Engineering Record

A Weekly Journal Devoted to Civil Engineering and Contracting
PUBLISHED BY MCGRAW PUBLISHING COMPANY, INC.

Volume 69 NEW YORK, SATURDAY, JUNE 27, 1914 Number 26

Chicago City Wastes Report

CHICAGO'S city waste problem has been before the public so long that it is hard to get much enthusiasm from the newspapers even over so admirable a report as that recently submitted to the City Council by a City Wastes Commission and abstracted in the Current News section of this journal last week. It embodied practically the whole of an expert's report for which there was so much necessity and for which the demand by civic organizations and the more enlightened citizens was so insistent. Seldom has a city-wastes problem—collection, transportation and disposal—been so thoroughly studied from the strictly engineering standpoint. For this reason the report should be given wide publicity and the details made available by an early publication of the findings in full. As previously stated in these columns, cities owe a debt to civilization in making public information obtained at great expense by their experts. The Chicago City Council cannot afford not to do its share in adding its mite to the meager amount of modern literature on city-wastes problems. Her experts have been educated at the expense of others' experience and she should reciprocate by making her data available.

Conference of City Managers

IN most lines of business there comes, periodically, a time for taking stock—of learning the amount and value of goods on hand and making provision for future needs. In the business of administering the affairs of cities according to the city-manager plan this time, apparently, has arrived, for from Springfield, Ohio, comes the announcement of a conference of city-managers to be held in that city Aug. 4, 5 and 6. This meeting, the first of its kind in the United States, will serve a most useful purpose in offering to men from many cities an opportunity for a frank discussion of the problems of this form of administration. Since the profession is a new one it is reasonable to assume that many situations have developed for which precedent offers no adequate solution and the exchange of ideas at the conference will do much to clear away uncertainties as to the best methods of conducting a city's affairs. Meetings of this sort have done a great deal of good, for example, in the field of waterworks. They should be equally effective in the case of the city-manager's work. In every city there is a different conception of the duties of city manager and every manager, no doubt, finds it quite puzzling to know what is expected of him and how far his authority extends. Success for the city-manager plan must be founded upon harmony between the governing body and its manager, and one of the first requisites for achieving this end is a definite understanding of the scope of the managers' duties. The conference will tend, among other things, to establish more definitely the relationship between the city manager and other municipal officials and by so doing will remove some of the confusion which now exists.

Reinforced-Concrete Piers

ON page 737 is presented the second extended article this month on reinforced-concrete pier construction. The issue of June 13, page 662, described the large pier of the Intercolonial Railway at Halifax, N. S., attention being confined almost entirely to the substructure. Special features of this work were the employment of cambered batter piles, the use of special cement to resist chemical action and the elaborate plant for casting, handling and driving the piles. In the main the viewpoint is that of the constructor. In the article in this issue on the San Francisco and Machina piers at Havana the attack is rather from the angle of the designer, with less attention given to the piles themselves and more to the superstructure. Both at Halifax and at Havana extremely long piles were used, those at Halifax running as long as 77 ft. and those at Havana being 85 ft. It is interesting to note on page 736 of this issue, however, that still longer piles—91 ft. in fact—are to be used on the next pier at San Francisco.

Return Feeders and Electrolysis

AN examination last month of the insulated return feeder system, installed in a substation district of the street railway system of St. Louis under the direction of the U. S. Bureau of Standards, demonstrated the effectiveness of this method of electrolysis mitigation. A report of tests of overall voltages and potential gradients has recently been made by Albert F. Ganz, Frank N. Waterman, Samuel S. Wyer, Howard S. Warren and Elam Miller. The conclusions are that it is feasible by means of a small number of insulated return feeders to bring about an approximately constant potential condition over a large area, and to reduce the drop in the tracks and, therefore, in the earth, to values which experience has shown afford a substantial measure of protection from injury by electrolysis to underground structures. These results have been attained at an initial cost which, according to the report, cannot be considered large, and at an annual cost which is small in comparison with the benefits derived. It is vital to the successful operation of the insulated return feeder system, as well as of any other system of electrolysis mitigation, that the rail bonding be kept in good repair. Special work, being particularly subject to vibration and to the loosening or breaking of bonds, should be independently shunted by jumpers of ample size. It is suggested that the installation of permanent pilot wires would be of great value as they would furnish a ready means of supervising and checking the condition of the return system.

Shall Chicago Step Backward?

SOME years ago Chicago, in line with progressive cities in Europe and a few in this country, decided to limit the height of buildings in the business section. The maximum limit was set at 200 ft., a figure which those who have studied the question exhaustively believe is too high, and which must be suffered only because it is now too late to do anything except compromise. But having made a step forward certain interests seem now to repent of their virtue and want to make an exception to the limit rule in favor of a proposed hotel. The promoters of the project want permission to erect a 260-ft. building, pointing out that in the neighborhood of the site selected there are structures which reach this elevation. Unfortunately the Mayor of the city seems disposed to favor the exception while the Chicago "Herald," in an editorial which, for its disregard of the great amount of data collected on height limitation is appalling, advocates not merely the exception but the entire removal of the height limit. Such ignorance is to be expected of country journals, but does not become a large metropolitan daily. If Chicago wants to court the congestion which obtains in lower New York the way is an easy one. Like New York, however, repentance will come before long and will do but little good. It will have to bear what it has brought upon itself and spend its millions more lavishly than otherwise in providing subway facilities to relieve the congestion. The concomitants of the high building—poor lighting and poor ventilation—are regarded lightly by the Chicago "Herald." Sanitarians, however, take quite a different view of these matters. For the sake of the city's future—and of its future generations—it is to be hoped that Chicago will abide by its 200-ft. limit.

The Worm Turns

A NOVEL answer to a grade-crossing damage suit has been made by the Erie Railroad. It seems that a milkman whose wagon had been struck at a crossing, and who had been pretty well smashed up along with his outfit, had sued the railroad. Not contented with the usual fight on the ground of contributory negligence, the company has put in a claim for damage to paint, polish and pilot of its engine, for expense in removing débris from its right-of way, and for the cost of stopping and restarting its train. The milkman had asked $25,000; the railroad modestly asks $100 only. In view of the Erie's recent penuriousness in the matters of clean coach windows and drinking water for its suburban patrons in the New York district the public will doubtless show scant sympathy for this latest move. The proposition is one, however, that deserves serious consideration. Much is said of the deadly grade crossing, with scant recognition of the fact that it has little danger for the man who heeds the warning signs. And there is a large class of people, otherwise honest, who look upon railroads as lawful prey and are ready to collect from them on any pretext. Therefore it is notable that the railroad follows its disclaimer of responsibility for the accident in question by a counter-claim. The collision was surely not an act of providence. Either the railroad was at fault and should pay for the damage done, or the milkman was at fault and should not be let off with his injuries, which in no way compensate the company for the losses it sustained. If the crossing was properly protected justice would seem to lie with the railroad, especially if the railroad was there before the street was. Unfortunately New Jersey, the State in which the accident occurred, does not perceive the injustice of making the railroads eliminate at their own expense even these crossings created by the State or municipality after the building of the railroad, but the point is an important one in all grade-crossing cases.

An English View of Mississippi River Control

NEARLY every year the Mississippi River breaks through its levees and causes damage that runs into millions of dollars. After each disaster large sums of money must be spent to build new embankments and repair the old ones, but rebuilding the broken levees and carrying them up to an elevation sufficient to withstand the record flood at that place increases the discharge in the river below and the next time the river rises the levees downstream from those repaired are called upon to withstand a flood larger than any previously recorded.

In a paper published on page 723 Sir William Willcocks, the eminent English engineer, tells how the Ancients would have regulated the flow of the Mississippi, compares conditions in the United States with those on the Nile, the Euphrates and the Tigris, and expresses opinions regarding the efficacy of the present levee system. The seasonal flood conditions in the Mississippi Valley are due to piecemeal levee construction without a comprehensive plan of controlling the flow of the river throughout its length. After one levee district has been established the river is not given sufficient time to adjust itself to its new or restricted course before other works are built which interfere with those already in place. Sir William Willcocks emphasizes the fact that the control of the Mississippi, unfortunately, was begun at its mouth. The problem would have been much simpler, he says, if the regulation had been started in the upper parts of the river and carried downstream, because if sufficient time is given the river to adjust itself it is a comparatively easy problem to provide an adequate channel between the levees.

As it is out of question to rebuild the expensive levees along the shores of the Mississippi, reliefs must be located at certain points in order to keep the flood discharge within the safe carrying capacity of the present channel. Sir William indicates that this can be done without excessive expense by using the St. Francis basin, which at the present time is sparsely populated. This basin would act as a reservoir, cutting down the peaks of floods below it and later feeding the water back into the river. American engineers from time to time have advanced the idea of by-passes and escapes for excessive flows and these methods of control have the endorsement of the English specialist.

It seems, from the English viewpoint, that American engineers in charge of the regulation of the Mississippi have put too much confidence in levees, while in fact the solution of the problem is to be found in a combination of levees and by-passes, escapes or natural reservoirs.

The Old and the New in Street Lighting

MUNICIPAL engineers who find themselves confronted with the renewal of city lighting contracts are just now in somewhat of a quandary. A rapid and extensive change is going on with respect to illuminants, and it brings with it the possibility of extremely radical changes in street lighting. For the first time there is now available a highly efficient lamp of a thoroughly practical character in units of moderate size. The tungsten lamp as used in the last few years is an excellent small unit, but not for a moment comparable in efficiency, that is in candlepower per dollar, with the modern arcs which came into use about the same time. At the present the nitrogen lamp is beginning rapidly to push out the older tungsten form of incandescent and will probably end by displacing as well all except the highest grade of arc lighting. For instance, the 6.6 amp, alternating-current inclosed carbon arc, of which thousands are still in use, must go. It gives at best not over one-fifth the light per watt of energy consumed that is given by the nitrogen lamp and much less indeed than is given by the ordinary tungsten lamp. At the present moment, however, there is one uncertainty in the situation which must cause the engineer some anxiety, and that is the probable price which will be demanded for service with the new lamps. In the past there has been a strong tendency to avoid competition between the incandescent lamps and the existing arcs by putting a relatively high price on the former. Now the strategy of the situation, in most instances, lies the other way, since a lighting company can give, let us say, for 300 watts more than twice the light that would be given by a 425-watt alternating-current arc. At present no prices have been even approximately fixed for service with the new lamps so that the whole subject is indefinite.

Still another phase of the matter lies in the renewed possibility of using several small units instead of one big one. The advocates of small lamps are many, particularly gentlemen who have ornamental lamp posts for sale, and these forces are now gathering for a renewed assault on the old method of lighting, perhaps to the encouragement of better lighting. The new viewpoint provided by the nitrogen lamps therefore gives prospects in both directions. The view will not be clear until, through the ordinary course of competition or by action of public service commissions, the proper price for the new illuminant shall be somewhere nearly settled. Until then it is a safe policy to go rather cautiously. Those who are dealing with high-grade arc-lighting installations with thoroughly modern equipment need not worry much. The burden of anxiety falls on those who are afflicted with ancient installations which ought to be discarded in spite of the investment represented.

The "Movie" in Technical Education

THE last report of the Commissioner of Education contains an almost startling amount of information regarding the application of the moving picture to serious educational matters. Of course, this is no new thing, since from all sides among the exploiters of the "movie" has arisen a cry about its educational value, generally, it must be owned, in matters concerning which people had better not be instructed. But as time has gone on extremely striking films of a real value from the standpoint of technical education have been evolved and are now available. For instance, the manufacture of many objects is now beautifully represented in cinematograph pictures which give a most vivid and accurate idea of the sequence of processes. One film may show the manufacture of a silk hat from the raw material to the finished "tile," another the building of a mammoth locomotive. By following the ingenious scheme of taking negatives at whatever periods are convenient, and running them off in rapid sequence, it has become easy to show the growth and blossoming of flowers, or the development of an insect, in a way that tells immensely more than could be mentally constructed from a series of personal observations.

From the standpoint of the engineer even more striking exhibits can be prepared, showing, for instance, the laying of railroad track or the digging of a canal, and in fact some extremely interesting views of this kind have been obtained on the Panama Canal, showing the operation of the machines which facilitated the progress of that huge undertaking.

There is no reason why these educational films cannot be used with great success not only to interest but to instruct students in technical subjects. For instance, what ordinary student has a clear idea, unless he has been more than usually fortunate, of the successive steps in the building of a large cantilever bridge, yet it would not be at all difficult to get up a film which would show in their proper sequence and in their relative consumption of time all the stages of growth in one of these important structures. The half has not yet been imagined of what the cinematograph can do in purely legitimate instructive work.

The chief difficulty at present is to get enough demand for strictly educational films to support their due production. The taking of the negatives, however, nowadays is so very simple a matter that a great deal can be done by technical institutions in providing their own films. Then it becomes merely a matter of ordinary library organization and interchange arrangement to keep them in use wherever needed. The inter-library loan is sufficiently well proved in usefulness and common in practice to enable a suitable interchange system to be carried out between all the institutions to whom such films would be useful.

Recent Progress in Prime Movers

NO work performed by the National Electric Light Association is of greater engineering interest than the annual report of its committee on prime movers, which has become one of the most valuable features of the convention program. Many interesting tendencies in design are emphasized in this year's review of progress as presented at Philadelphia. Perhaps the most striking point is the entire omission of the reciprocating steam engine from the compilation of prime-mover improvements during the past twelvemonth. The steam turbine seems to have become the standard equipment for large fuel-burning installations of new design, although the outlook is bright for a wider use of the oil engine in cases where small-powered units are sufficient and where the price and supply of liquid fuel are satisfactory. It appears that the further development of the gas engine depends mainly upon the progress of the gas producer, which still needs skilled attention for first-class operating results.

Much work has been done in turbine design in simplifying cylinder castings to avoid internal strains and facilitate machine operations, and to make blade replacements easier. Blading is being designed with closer attention to the even distribution of stresses. The manufacture of units of 30,000 and 35,000-kw rating marks a steady advance in capacity. Moreover, one turbine maker has adopted a compound unit with expansion carried out in two cylinders, each driving a separate generator, with a governor on the high-pressure end controlling the entire 30,000-kw unit. Another builder adheres to the single machine type of design, in which stronger bucket and wheel material permit increased rotative speeds without sacrifice of previous liberal factors of safety. Additional safeguards have also been provided against the dangers of excess speed resulting from careless operation. Through improvements in gearing, the direct-current generator and other power-plant apparatus are being successfully turbine-driven at favorable speeds.

Manufacturers are working on the problem of bringing down the cost of the gas engine, which has long since attained a very satisfactory stage of efficiency and reliability. Beyond the mechanical design, the workmanship and selection of materials are important. Piston rings, for example, must be tight to a degree scarcely understood by steam-engine builders. Finality in design has not yet been reached in either gas or oil prime movers and before these can become common in large work, a great deal of development will be necessary. English conditions point to about 1000 kw as the maximum capacity in oil engines that may be economically employed in that country at present, whereas about one-half this rating appears to be the limit in the United States, subject to exceptions in special cases.

With reference to water wheels, the report emphasizes the importance of measurements of flow and efficiency in a testing flume adequate in size to accommodate larger hydraulic turbines than may be handled at Holyoke, touches upon the general subject of stream measurement, and points out the tendency to eliminate the center bearing in wheels of the horizontal double runner, central discharge type, either designing the shaft to meet the conditions of suspension or arranging for the alignment of the shaft by raising the rear bearing. The full report merits examination by engineers interested in the latest ideas regarding prime movers, condensing equipment and other auxiliaries of efficient station operation.

A Model Street Cleaning District for New York City

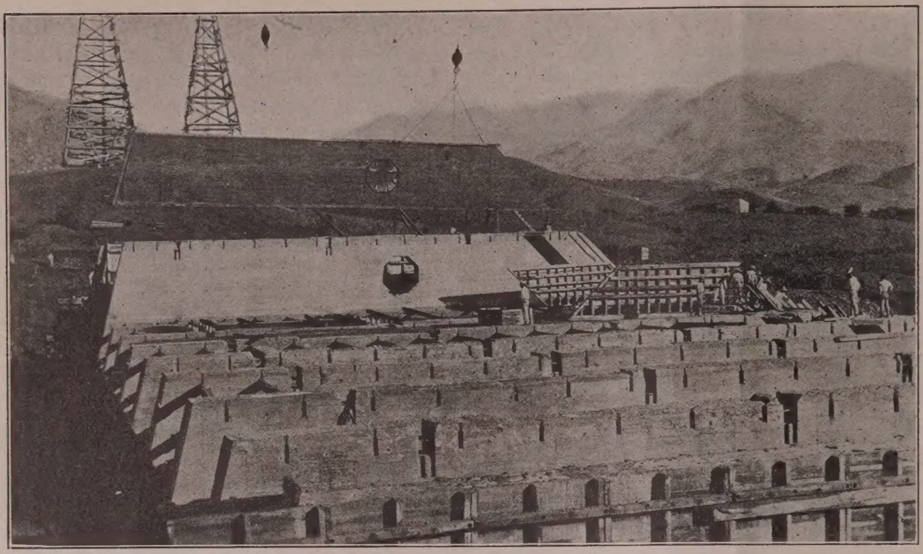
SEVENTEEN years ago Colonel Waring reorganized street cleaning methods in New York City and did his work so well that department heads of succeeding city administrations have been content, one after another, to follow more or less closely in the footsteps of their distinguished predecessor. Upon this pioneer devolved the task of bringing order out of chaos but in these days of rapid advances in all the professions it is not enough to rest upon the efforts of almost two decades ago.

New York City has outgrown the street cleaning and refuse disposal system of Colonel Waring's time. Population has increased, the boundaries of the city have been extended, traffic is congested, and today the commissioner of street cleaning faces a problem of broader scope and greater complexity than existed in the old days. Commissioner John T. Fetherston has made a careful analysis of the street cleaning and refuse disposal situation and has recommended a number of radical changes which are embodied in a report reproduced in abstract on page 741. Briefly, the commissioner proposes to establish in the borough of Manhattan a model street cleaning district and equip it with modern appliances instead of the obsolete apparatus with which the work is now done. This district will serve as a basis for the future development of the city's street cleaning methods. The improvements, it is estimated, will cost $253,000, and will reduce the annual cost for operation, maintenance, interest and depreciation from $359,327, the charge under the present system, to $304,985, a yearly saving of $54,342 in a single street cleaning district.

The main feature of the proposed plan is the replacement of horses with motor tractors, each fitted with three types of trailers, one for street flushing or sweeping, one for refuse disposal, and the third for plowing, sweeping and hauling snow. The tractor-trailer system, obviously, is one of great flexibility, for no single motor will be limited to a single kind of work and working hours will not be confined to a single shift. By extending the functions of the equipment and increasing the hours of work for the tractors fixed charges will be decreased and lower costs will be secured than is possible with horse-drawn equipment. This is not guess work. A careful analysis of the situation was made and the conclusion is based upon first costs and costs of operation, taking into account the extra hours of work for the tractors as compared with horses.

The report goes farther than the cleaning of streets. It makes provision for the collection and disposal of refuse. Under the new system the separation of household refuse into three classes will be continued and each building—in the model district at least—will be furnished with a set of cans. The garbage can will have an attached cover and will be painted a distinctive color to distinguish it from the ash can. Rubbish will be tied in bundles as required by existing ordinances. The distinguishing feature of the proposed method of handling the garbage, therefore, is the closed system which will obviate present nuisances from odors, flies, dust and loose paper. In place of open dumps at the waterfront a closed transfer station with an electrically operated telpher system for unloading the refuse containers from vehicles to scows is recommended.

To carry out Commissioner Fetherston's recommendations will require a special appropriation by the Board of Estimate and Apportionment. The board should not delay in providing funds for this work. It is a long time since New York has had a technically trained commissioner of street cleaning. Now that the city has such a man let her profit by his special knowledge. The commissioner has done his part in preparing a plan which not only promises to be a vast improvement over the one now in use but also points to substantial economies in the cost of doing the work. The recommendations are made by a man whose special training qualifies him to diagnose the city's malady and prescribe the proper cure. This he has done. There is but one logical course for the Board of Estimate to follow—provide the funds for doing the work.



Handling Wooden Buttress Forms with Cableway

Constructing Hollow Reinforced Concrete Dam in Porto Rico

Work on Guayabal Structure for Irrigation Purposes Was Done by Administration Forces After Excessive Bids Were Rejected

By L. V. BRANCH
Division Engineer, Porto Rico Irrigation Service

IN recognition of the importance of the sugar industry to the Island of Porto Rico and the necessity for an extension of irrigation facilities by other methods than expensive pumping, the Government, in 1907, made an appropriation for a preliminary investigation of the feasibility of the storage of the flood waters and the diversion of additional waters from the north slope of the island. A year later the Irrigation Service was organized and provided with funds for the construction of an extensive irrigation system. This organization provided the community interest necessary for any extensive development. Payments for the work will be made by the lands benefited. The construction work on this system is now nearing completion.

Of a total of slightly over 60,000 acres in the irrigation district over 43,000 acres are irrigable. The scheme of irrigation divides itself naturally into two independent systems, the eastern extending from the Patillas River westerly to the Salinas River, and the western covering the area from the Salinas River to the Jacaguas River. Of this irrigable area, 19,700 acres are located under the western division comprising the Juana Diaz canal and Coamo dam, the Guayabal dam and Toro Negro diversion. The Guayabal dam is a very important link in this system for it controls the flood waters of the Jacaguas River, stores the waters diverted from the north slope by the Toro Negro diversion and creates a reservoir for supplying the Juana Diaz canal.

Of the average rainfall of 47 in. over the irrigation district about 60 per cent, or slightly over 2 ft., is considered the beneficial portion for crops. As the irrigation law provides, as a standard for the district, for the delivery of 4 acre-feet per annum, which will be measured at the headgates of field laterals, the lands should receive an average of nearly 72 in. beneficial water per year.

The dam is constructed across the bed of the Jacaguas River about 7 mi. above its mouth, where the bed of the river was 220 ft. above sea level. It backs the water up a distance of 2½ mi. in the Jacaguas valley and about the same distance up the valley of the Toa Vaca River. The reservoir covers 322 acres with a maximum depth of 100 ft., an average depth of 31 ft. The storage capacity to spillway level is 10,000 acre-feet, which will be further increased to nearly 11,000 acre-feet by the addition of 3-ft. automatic flash gates on the spillway crest.

The dam site could not be called a favorable one for a reservoir of this capacity, for the flood channel width of the river was 220 ft., and at an elevation of 80 ft. above low water the valley was 880 ft. wide. Above this height the hills fell back sharply in long ridges. On the easterly ridge the dam was extended as an earth embankment. On the westerly ridge, which was the flatter, a spillway has been provided.

In considering a type of dam for this location it was found that earth of suitable quality and quantity was not available. A gravity masonry dam was designed for the river section, this being extended by earth dams at both ends. Specifications were issued and bids received, but the bids were rejected as being excessive and the construction of the dam by administration forces was authorized. The change in the type of dam to a hollow reinforced concrete dam was made after the work was authorized for construction by administration forces.

FOUNDATION

The foundation is diorite overlaid, except in the river section, by a decomposed rock and clay varying from 12 to 30 ft. in depth. There was a gradual change from the clay of the surface through the various grades of decomposed rock to the solid rock underneath. Where the excavation was deep the entire area had to be stripped, but for the shallow footings and for the lower portion of the deeper footings the excavation through the decomposed rock was in the form of a trench for each buttress and a continuous trench for the cutoff wall at the foot of the deck of the dam. The minimum width of any trench was three feet, but due to shooting, etc., the average width was considerably greater. These trenches were all partly backfilled with concrete without the use of forms, forming a heavy spread footing for all the walls of the dam.

The dam is of the Ambursen hollow reinforced concrete type. Its principal dimensions are as follows: Length of earth embankment with concrete core wall, easterly end of the dam, 303 ft.; length of the bulkhead section constructed across the river channel, 918 ft.; length of spillway section forming the westerly end of the dam, 756 ft.; total length of the dam, 1977 ft.

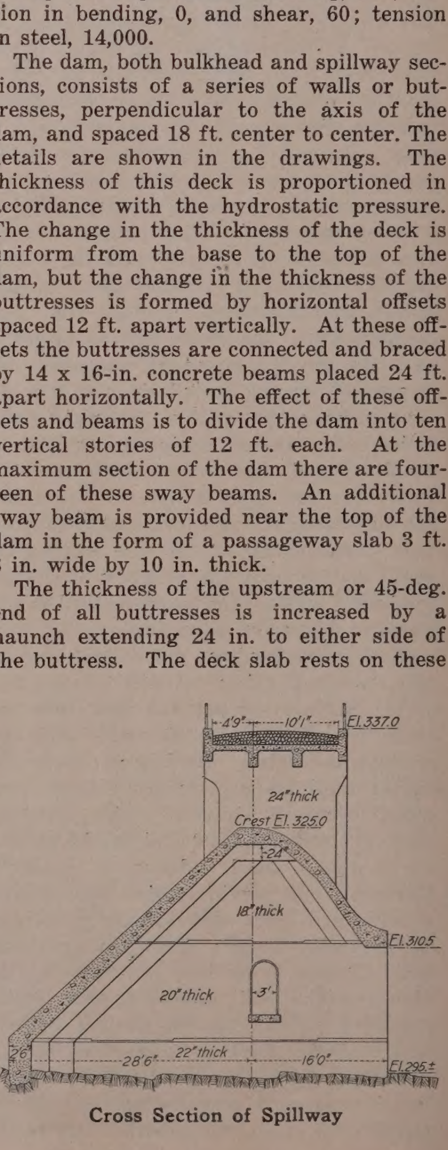
The maximum height of the dam from lowest point of foundation to the top of parapet walls is 120 ft., while the height from the former bed of the river to roadway is 115 ft. The width up and down stream at the base of the dam is 138 ft. Both the bulkhead and spillway sections of the dam support a highway bridge with a 15 ft. roadway.

DESIGNING DATA

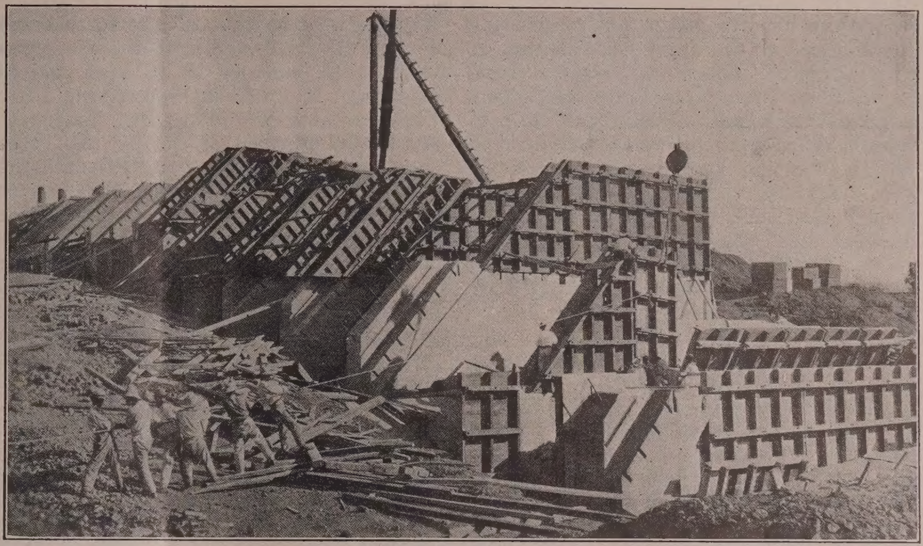
In designing the dam the maximum safe bearing value for the foundation was assumed to be 10 tons per square foot. For the concrete the stresses in pounds per square inch were: Buttresses in compression, 300, and in direct shear, 100; deck and apron compression in bending, 600; tension in bending, 0, and shear, 60; tension in steel, 14,000.

The dam, both bulkhead and spillway sections, consists of a series of walls or buttresses, perpendicular to the axis of the dam, and spaced 18 ft. center to center. The details are shown in the drawings. The thickness of this deck is proportioned in accordance with the hydrostatic pressure. The change in the thickness of the deck is uniform from the base to the top of the dam, but the change in the thickness of the buttresses is formed by horizontal offsets spaced 12 ft. apart vertically. At these offsets the buttresses are connected and braced by 14 x 16-in. concrete beams placed 24 ft. apart horizontally. The effect of these offsets and beams is to divide the dam into ten vertical stories of 12 ft. each. At the maximum section of the dam there are fourteen of these sway beams. An additional sway beam is provided near the top of the dam in the form of a passageway slab 3 ft. 8 in. wide by 10 in. thick.

The thickness of the upstream or 45-deg. end of all buttresses is increased by a haunch extending 24 in. to either side of the buttress. The deck slab rests on these



Cross Section of Spillway



Forms for Buttresses of Hollow Concrete Dam

haunches, the deck slabs being cast separately, a 12-ft. lift at a time. The sides of these deck slabs are formed by the buttresses which extend beyond the haunch to the finished outer face of the deck. Bonding grooves are provided for the deck slabs in the concrete of the buttresses forming the side of the deck slab and also in the top of the deck slab below.

In addition to these bonding grooves a double layer of 3/16-in. soft pad felt 4 in. wide and Sarco waterproofing asphalt, applied hot, is provided on the face of all haunches. In applying, the surface of the haunch was brushed clean, and close up to the buttress was applied a heavy coat of primer paint. On this was mopped an 1/8-in. layer of asphalt, the 4-in. strip of felt being placed while the asphalt was still hot. A second layer of asphalt and felt were then applied and the upper surface of the felt received a final mopping with asphalt. The deck slab is cast on the haunch and this layer of waterproofing. In general, the buttresses and deck for the spillway section are the same as those for the bulkhead section.

The spillway with net waterway opening of 714 lin. ft. is calculated to carry 70,000 sec.-ft. under a 9-ft. head.

On the bulkhead section every buttress and on the spillway section every other buttress is extended above the deck at the top of the dam to form piers for the bridge. Hence this bridge consists of fifty-one spans of 18 ft. each and twenty-one spans of 36 ft. each, making the total length of the bridge 1674 ft.

EMBANKMENT

The earth embankment at the easterly end of the dam has a length of 303 ft., a maximum height of 28½ ft. on the center line, but a total height of 40 ft. for a considerable length of the upper face. The crest width is 20 ft. and at El. 336.5, which is 11.5 ft. above the spillway crest. This embankment contains 8 ft. upstream from its center line, a corewall of plain concrete. This wall has a top width of 18 in. with a crest 10 ft. above the spillway level and has a maximum height of 45 ft. The downstream face of the embankment has a slope of 2 to 1 and the upper face a slope of 2½ to 1. This upper face has a rock paving 12 in. thick.

At the river bed are located two 24-in. circular sluice-gates discharging into the old river channel. Seven feet higher are located four more similar gates.

All concrete in buttresses was a 1:3:6 mixture, while all decks and the crest and apron of the spillway were made of a 1:2:4 mixture. A 1:2½:5 mixture was used to a considerable extent for cutoffs, beams and minor portions of the work. Atlas cement was used, this cement being delivered to the Irrigation Service f.o.b. lighters in Ponce Harbor, 12 miles from the dam site.

CONSTRUCTION METHODS AND PLANT

No special machinery was used for any of the excavation. All material for the embankment and from the foundation for the dam was taken out with pick and shovel. Hand churn drilling was in general used for blast holes in the decomposed rock found in the trenches while machine drills were used at a few locations where there was a considerable section of hard rock to come out. Stiffleg derricks were moved along the upper face of the dam to remove the material from the deeper portions of the excavation for the cutoff trench. These derricks were also used for the moving and erection of forms for the buttress haunches and decks within their reach, relieving the cableways of that much work.

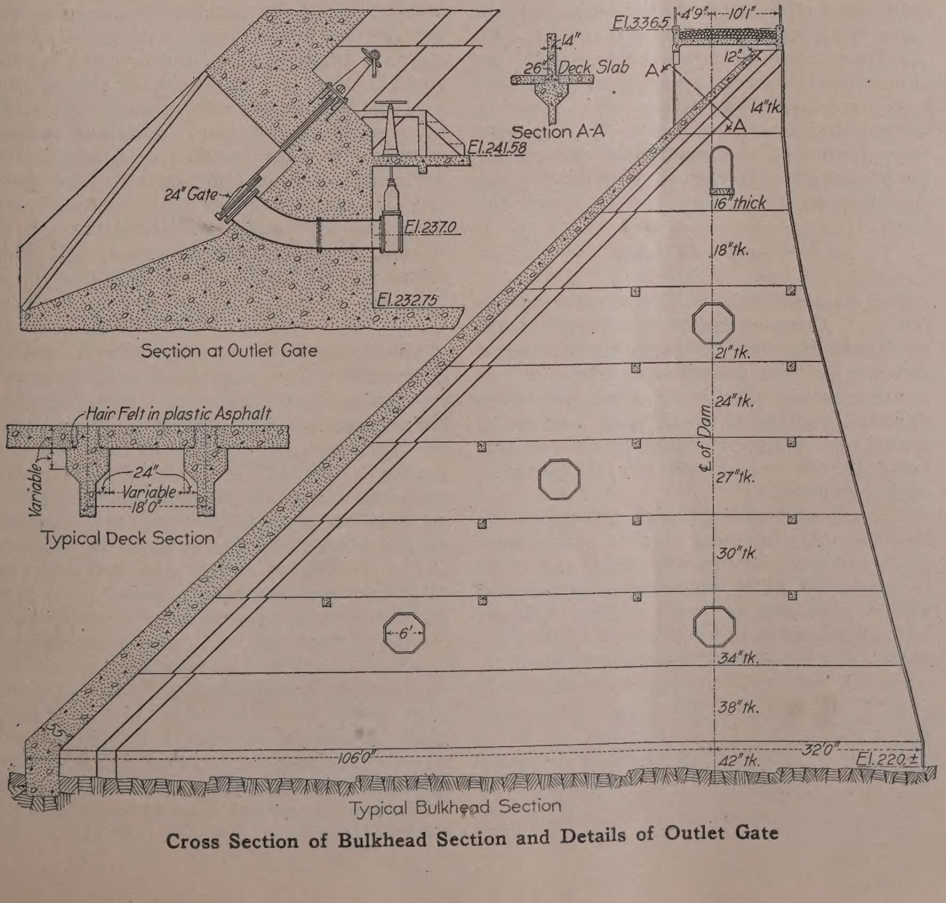
Concrete from two 1-cu. yd. Smith mixers was handled from the mixers to the forms in Dowd pattern combination buckets and cars of 1 cu. yd. capacity. Eight of these cars were in use. Transportation from the mixer tracks to the forms was handled by two 8-ton capacity Lidgerwood stationary cableways.

FORMS

The forms for the buttresses were made of 2-in. surfaced, short-leaf pine in panels 6 ft. wide by 12½ ft. high. Each panel had three 3 x 6-in. studs and four 4 x 6-in. waling pieces or strongbacks securely bolted together. The end studs were all bored for the 7/8-in. bolts used in joining the forms. In erection 7/8-in. bolts were passed through the buttress from strongback to strongback, within the form, being inclosed in a sheath and separator made of two pieces of 1-in. board, 2½ in. wide, with a ½-in. groove in each piece. These separators were not removed from the concrete.

To form the haunch on the 45-deg. upstream slope, a three-piece form was used consisting of the 45-deg. miter form, which was made up similar to the flat panels, the form giving the under side of the haunch, and the insert form giving the seat of the deck slab. The forms were bolted to each other and through the buttress as were the straight forms. These haunch forms were lagged with 7/8-in. flooring running up and down the 45-deg. slope.

The deck forms were entirely supported by the buttresses. The under deck forms were made up of 2-in. lagging running up and down the 45-deg. slope and resting on adjustable steel purlins made up of two 8-in. channels provided with suitable bolt holes and slots so that the purlins could be adjusted between adjacent buttresses. As the upstream end of the buttress extends



Cross Section of Bulkhead Section and Details of Outlet Gate beyond the haunch line to the true outside line of the deck the upper deck lagging of 1-in. boards was placed horizontal and resting on these ends of the buttresses. This lagging was lightly nailed to 2 x 6-in. rafters, which were in turn securely held to line by strongbacks. Seven strongbacks were used for each deck panel. These strongbacks were made up of two 9-in. 13.25-lb. steel channels 19 ft. long. A 1¼-in. removable bolt, which had been cast in the buttress concrete, secured each end of each of these strongbacks.

Diversion of River

During the period that the dam has been under construction the flow of the Jacaguas River has varied from a minimum of 7 to a maximum of 60,000 sec.-ft. Due to the fact that in the bed of the river little excavation was required to reach bedrock and that the type of dam made it easy to divert the river between buttresses as they were completed, the care of the river was an inexpensive operation. Working from both sides of the river the buttress foundations with connecting cutoff trenches were unwatered, excavated and refilled one or two at a time, by the use of low sand bag and earth dams. After the river had been confined to a narrow channel it was turned by a sand bag dam over the completed cutoff wall and back of buttresses, which prevented its return to the excavation in progress.

Seven sections of the deck at the base of the dam were left out to care for the flood flow in the river. Six of these openings were 11 ft. wide by 20 ft. high and the seventh 11 ft. by 13 ft. high, giving a total waterway area of 1463 sq. ft. During the 60,000 sec.-ft. flood of Oct. 7, 1912, these openings proved inadequate, although they were acting under a head of 12 ft. at the top of the opening. The flood passed over the full length of the river section of the dam. This exceptional flood, the greatest recorded on this stream, caused a minor loss in forms and tools, but a more serious loss in delay to the work due to the interruption to communication and transportation facilities.

Materials and Supplies

Some of the principal items of materials and supplies used in the construction of the dam are given in the first table.

The total excavation for the dam has been 68,452 cu. yd., and the total concrete placed 44,137 cu. yd. The first concrete was placed in the embankment core wall on Dec. 26, 1911, and the last concrete was placed in the spillway section of the bridge Sept. 1, 1913. Only one 10-hour shift per day was worked, there being no regular night work nor Sunday work, but the cableways were usually worked one or two hours overtime in moving materials and forms. The local labor supply was employed almost exclusively, a maximum force of 9 men from the United States being the greatest number employed at any one time. The local laborer is strictly an agricultural laborer, except some few who have received experience and training around the sugar centrals. No quarters were furnished common labor and no attempt made to attract such labor from other localities except as they chose to seek the work.

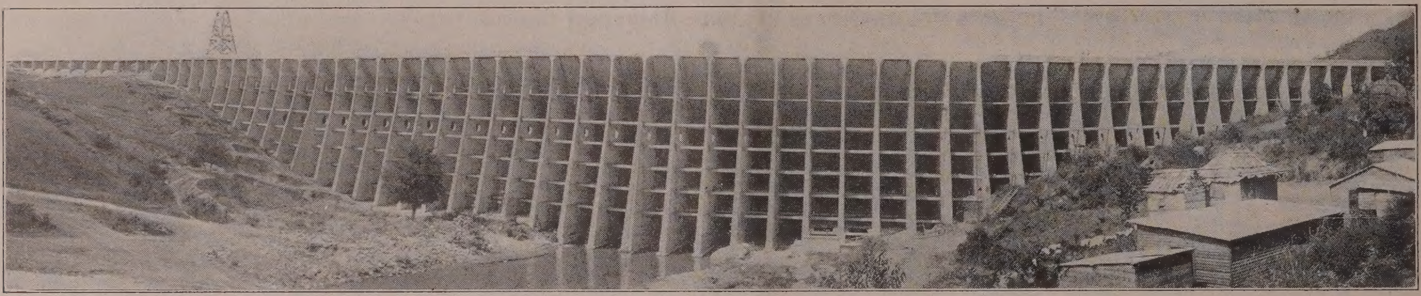
Wages and Costs

The general scale of wages paid was as follows: Common labor on pick and shovel work, 7 to 7½ cents per hour; common labor showing skill in quarry, concrete work, or around machinery, 8 to 9½ cents per hour; mechanics' helpers, firemen, etc., 10 to 15 cents per hour; carpenters, blacksmiths, hoist runners and mechanics, 17½ to 25 cents per hour.

The average cost of trench excavation for foundations, consisting of clay, gravel, clay and boulders, decomposed rock and solid rock in cutoff, all of which had to be loosened either with pick or powder was, unclassified, $0.85 per cu. yd. The cost of the concrete in the bulkhead section of the dam, itemized, and the average cost for the whole dam are given in the accompanying tables.

The unit cost of the concrete in the spillway dam was $12.09 per cu. yd., the increase being due to the smaller and more complicated forms. On this work the forms cost $2.16 and reinforcing steel $1.54 per cu. yd.

The dam was built by administration forces of the Porto Rico Irrigation Service, under the immediate direction of the writer. The plans for the dam were furnished by the Ambursen Company, which has also furnished plans for two other dams now being constructed in Porto Rico. On the construction of all three of these dams Norman Rand Willard is local representative of the Ambursen Company. J. W. Beardsley is chief engineer of the Porto Rico Irrigation Service.



Downstream Face of Guayabal Dam, Built by the Porto Rican Irrigation Service, Showing Spacing and Bracing of Piers

Principal Materials

Item.	Total.	Per cu. yd. of concrete.
Cement	52,475 bbl.	1.19 bbl.
Reinforcing steel	808 tons	36.6 lb.
Lumber, for forms	382 M. b.ft.	8.6 b.ft.
Lumber, for other uses	355 M. b.ft.	
Steam coal	2,501 tons	.056 tons

Cost of Concrete in Bulkhead Section

Item.	Cost per cu. yd. of concrete.
Crusher rock delivered, 500 to 1000 ft.	$0.65
Sand delivered at plant, 1 mile	0.49
Cement, 1.17 bbl., Atlas, at $2.56, delivered	3.02
Power, water and repairs (coal, $10.50)	0.42
Labor:	
Crushing plant	0.05
Mixing plant	0.13
Handling sand	0.07
Handling cement	0.07
Placing concrete	0.21
Placing steel and waterproofing	0.06
Miscellaneous, sprinkling, etc.	0.02
Forms (lumber, $0.27; labor, $1.22)	1.49
Reinforcing steel, $41 per ton, delivered	0.64
Miscellaneous supplies	0.11
Transportation of concrete and forms	0.47
Depreciation of equipment	1.20
Proportion of general expense	0.29
Blacksmith shop charges	0.03
Expenses, preliminary (design, purchase and installation of plant, camp and organization)	0.79
Unwatering dam site, temp. dams and pump'g	0.10
Flood damages due to exceptional flood	0.20
Engineering, clerical, medical, etc.	0.22
Total unit cost	$10.73

Summary of Concrete Costs

Bulkhead section	37,442 cu. yd. at	$10.73 per cu. yd.
Spillway section	5,250 cu. yd. at	12.09 per cu. yd.
Core-wall in embankment	1,445 cu. yd. at	8.13 per cu. yd.
Total concrete in dam	44,137 cu. yd. at	$10.81 per cu. yd.

Detroit Building Regulations

New building regulations for the City of Detroit place the following limitations on the ratio of least diameter to length of unbraced piers and columns: Brick or hollow tile, 1 to 10; wood, 1 to 16 and 1 to 24; cast iron, 1 to 20 and 1 to 30; steel, 1 to 44. Working loads on masonry in tons per square foot are limited as follows: Brick work in lime mortar, 7; in lime and cement mortar, 9; in lime and Portland cement mortar, 11; in Portland cement mortar, 15. For pressed brick, 20 per cent excess of the above is allowed. For hard hollow tile with vertical cells laid in Portland cement the load is 20, and with horizontal cells, 12; for ordinary hollow tile in Portland cement mortar, 12½ for vertical cells and 7 for horizontal cells; rubble stone in lime mortar, 5; in lime and cement mortar, 6; in lime and Portland cement mortar, 7; in cement, 8; in Portland cement, 10; concrete, 8; Portland cement concrete footings, 30.

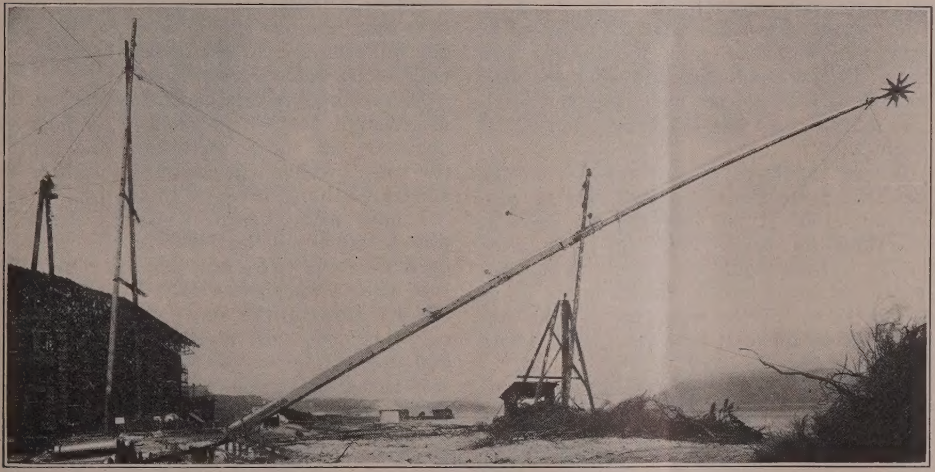
Breaking Up Pavement between trolley tracks with a plow is effected by a device designed by Charles H. Clark, engineer maintenance of way of the Cleveland Railway and described by him in the "Electric Railway Journal." A service motor car pulls the plow, which consists of a heavy steel casting of suitable shape for lifting the paving blocks and for cutting the tie-rods at the same time. Three men and the crew of the car are all that are needed to operate the machine. It has been found possible, in preparing for track work, to remove 1300 sq. ft. of pavement in one minute. On another occasion the pavement in a stretch of track 2600 ft. long was removed in thirty-five minutes. The plow, which has been in use for about three months, is needed for service but once or twice a week, as an hour's work will prepare enough track for eight or twelve days.

Tallest One-Piece Flagpole

Three Derricks Raise 227-Foot Single Stick at Exposition Grounds, San Francisco

THE Douglas fir flagpole erected on June 9 beside the Oregon building at the Panama-Pacific International Exposition is unique in that it is a single stick with an overall height above the ground of 227 ft., set in a foundation calculated to support it without guy-wires under heavy wind stresses and with a 46-ft. flag. The foundation is a reinforced concrete block 20 ft. square and extending 10 ft. below the surface. Only half of the socket was poured prior to the pole raising so that the base could be placed on the bottom of the socket before erection. Rods were left projecting from the first portion of the foundation block so that when the pole was erect the remainder of the concrete could be poured around it.

As finally completed the pole is imbedded in the concrete for a length of 11 ft., a 3-in. grouting having been poured around it to fill the space left in the rough-cast socket. In the foundation, around and underneath the pole there is a total of 150 cu. yd. of concrete. As the pole is to stand only some eighteen months it was decided that with a treatment of avenarius carbolineum a galvanized iron sheathing would not be necessary for the imbedded portion. At the base the diameter is 4 ft., and at a height of 27 ft. the pole is shaped to a hexagonal section 3 ft. 5 in. in diameter, and from this point there is a uniform taper to a diameter of 15 in. at the top. The length of the pole itself is 222 ft. of which 8 ft. is below ground level. It is surmounted by a metal star with 5-ft. arms which weighs 620 lb. and adds a total of 13 ft. to the overall height of the pole.



Raising 235-Foot Wooden Pole at Exposition Grounds

POLE WEIGHS 35 TONS

When ready for placing the pole weighed 35 tons and three derricks were used in erecting it, holds being taken at four points as shown in the accompanying illustration. The shear-leg derricks were 75 and 110 ft. high respectively, and the stiff-leg derrick had a 90-ft. boom. The first hold was taken at the center of gravity, about 80 ft. above the base, and the others at 90, 125 and 130 ft. respectively. The raising was done very slowly, a few feet at a time, and about three hours were consumed in getting it into the upright position. Six temporary guys were attached, but after the foundation concrete has set these will be removed, when the pole will be expected to resist the bending moment of a wind pressure of 30 lb. per square foot in addition to the pull of a 46-ft. flag exerted at the peak.

The pole was donated to the exposition by the city of Astoria, Ore., and the setting and method of erecting it were planned by exposition engineers. The working of the rough timber into the finished shape ready for painting required the time of six men for a period of ten days. The total cost of placing is said to have been about $2,500.

How the Ancients Would Have Controlled the Mississippi and Its Tributaries

Abstract of a Paper by Sir William Willcocks Read May 13 Before the Engineers' Society of Western Pennsylvania—Part I

REGULATION of the Mississippi began at its lower end and levees were constructed to protect that section in times of flood. At that time the river was not restricted in any way in its upper parts and there it overflowed and inundated large basins which acted as storage reservoirs in retarding the discharge, thus making the floods last longer but depriving them of their violent culmination. Later on when these parts were provided with levees the flood discharge in the river was increased, necessitating the heightening of the levees at the lower part. As levees are constantly built the conditions are getting worse instead of being improved. This is the belief of Sir William Willcocks, the eminent English engineer, expressed in a paper read at the May 13 meeting of the Engineers' Society of Western Pennsylvania. This paper was published in the March issue of the "Proceedings" of the society, the source of the following abstract:

The Mississippi is about four times the size of the Nile, seven times the size of the Tigris and twelve times the size of the Euphrates. But size in these questions has nothing to do with difficulty. Accidents happened on the Mississippi in 1912 and 4,000,000 acres were inundated—the whole of Egypt is only 6,000,000—and little thought was taken of it in this country. In the seventh century of our era a very serious breach occurred in the Tigris levee and the King on that occasion threw 400 engineers and supervisors into the breach.

The Mississippi, unfortunately, has been reclaimed from the mouth up. Louisiana made fields and gardens behind its levees. When the next State farther up the river made its levees and concentrated the flow it put Louisiana into difficulties. Louisiana raised its levees and then it went easier until the next State upstream started to build levees. And however hard Louisiana works it can barely keep ahead of the difficulties brought on it.

MISSISSIPPI BELOW CAIRO

The Mississippi from Cairo to the sea has a length of 1000 mi., in a straight line it is 550 mi., and the width of the valley is about 50 mi. The fall in flood is 320 ft. and in low water 270 ft.; 1540 mi. of levees are along its banks. (In Egypt we have about 900 mi. of levees.) The salient points, where the Mississippi bends from side to side, need protection and cover 400 mi. The natural reservoirs in the Mississippi valley, which I shall call basins to distinguish them from reservoirs which are proposed in the hills, cover a very large area. The St. Francis basin with 4,000,000 acres, the Yazoo with 4,000,000, the Tensas with 3,000,000, and smaller reservoirs on the sides, bring the total above the Red River to 12,500,000 acres. Downstream from the Red River are 6,500,000 acres, giving altogether 19,000,000 acres of natural reservoirs.

Like all deltaic river valleys, that of the Mississippi is highest near the river bank and slopes away to the hills on either side. In places the water at the bank is 30 ft. higher than at the hills, so that when the water makes a breach it has plenty of land to go over and finds it very easy to get away. Then this river, like all deltaic rivers, brings down a great deal of sediment. But the river soon begins to drop this into its bed, and then cuts out from the sides at the bends. Low down in its course nearly the whole of the sediment in the river is that which the river itself is cutting from its own banks.

Allowing 6 ft. of water above the natural bank of the river, which is where the flood of 1882 came to, these natural basins, or reservoirs, in the Mississippi valley itself represent about 12,500,000 acres, 8 ft. deep, or 100,000,000 acre-ft.

RESERVOIRS AN ASSET

If the ancients had had this river, they would have considered these reservoirs as a great asset, and never would have used them or let them be cut by levees until they were quite sure that all the lands below were well protected against inundation. As the first lands to be reclaimed were in Louisiana, the next basin above it is the Tensas. They would have done one of two things. They would have either run the levee down one-half the length of the Tensas, letting the other half be flooded, or they would have taken half the basin in the length of the river and surrounded it with levees, and let the river go around the other half. But they would not have allowed a levee to be put up until the lower ones had been strengthened. Having done that and allowed eight or ten years for the river to adjust itself to the new conditions, they would have gone to the next basin, the Yazoo, and taken half of it and treated it in the same way, previously protecting all the levees below. Then in thirty or forty years they would have gone to the next, the St. Francis, and treated it the same way.

As this operation went on and the waters were cut off from overflowing the basins and kept within the channel, the river would gradually have widened and deepened itself to meet the new conditions. It would have needed time for that, but you people in this country give nothing time, and the Mississippi River has had no time to do anything in all the operations that have been performed on it. Every time a breach or crevasse occurs in a levee the river downstream for 50 or 60 mi. is totally disorganized, all the good done in previous years is thrown away and the work of making the channel suit its new conditions has to be done again.

If you go down from Cairo, the first basin on the right bank is the St. Francis, with 4,000,000 acres, and it has a levee along almost its entire length. The Yazoo basin of 4,000,000 acres on the left has a levee along almost its entire length. On the right bank the Tensas with 3,000,000 acres has the same; and from the Red River on, both banks have levees past New Orleans to the sea. The small basins are unprotected.

WHAT SHOULD BE DONE

I will lay down a few propositions. Before a basin like the St. Francis is allowed to have a levee, from the end of that levee downward, calculations should be made and the height of the flood which is going to be artificially produced by that levee, calculated. Then profiles of levees 5 ft. above flood should be put up, 10 ft. wide, every 10 mi. all the way down the river, so that every man could see for himself the terrible condition that is coming.

If, for example, the Mississippi when in its banks discharges 1,000,000 sec.-ft. with a velocity of 6 ft. it has worked out for itself, owing to the kind of soil which it has in its valley—and a very poor and bad soil it is to resist the current—it has cut out for itself a channel 5000 ft. wide and 33 ft. deep. If you put the whole discharge of 2,000,000 sec.-ft. that passes Cairo into the stream it would begin by having a depth of 48 ft. or it would rise 15 ft. at once, and with its width still 5000 ft., a velocity of 8 ft. a second, which is a great increase. It would undoubtedly begin to widen itself. This river has a width which is 150 times its natural depth, so that when you increase its depth by 15 ft. it would want to increase its width by over 2000 ft. But as it increases its width by every 10 or 11 ft., the section increases and its depth falls. With water, which is wonderful in its adjustment, the stream would adjust itself and in time, if left alone to work out its own salvation, it would become a river about 6500 ft. wide and say 40 ft. deep. And so, gradually working in this way, you would have your river only 7 ft. above its banks in highest flood. But working suddenly and raising suddenly is not engineering.

More important even than the levees as the river sweeps around its bends in its valley are the protective works at its sides. This protection is very well done in this country. Not enough is done to keep pace with the requirements of the river, but what is done is well done. The river, instead of tearing down its banks in poor soil, is fixed by matting and stone, as though it was flowing between hills. With these protective works I consider that, if the river in its natural soil can run 6 ft. a second without difficulty, it could take 7 ft. quite easily if well protected. Now in this country there is no nervousness in raising the water 15 ft. in height and increasing the velocity from 6 to 8 ft., but the extra velocity that would come from these great bends being cut across to make the channel shorter has occasioned extraordinary nervousness. Yet of the two, as I see it, this is the less dangerous. If you increase the velocity from 6 to 8 ft. that velocity goes clear down the whole river; but if you cut off a bend and increase the velocity at any point you immediately decrease the depth, and this adjusts itself.

On the other hand, if you let a cut off take place in a high flood when the river is full and the velocity great, you court enormous damage. Such things the ancients would have done just after the flood. They would have cut so that the river would have had eight or nine months to flow under its new conditions and when the next flood came it would not have been very serious, as the river had adjusted itself to its channel.

Where the levee is far away from the mattress protections it might pay to protect only 1000 ft. per mile and let the river bite into its banks between these fixed points. There would be a limit to the biting action and a million dollars might go as far as three million would go if you protected every inch. It is worth trying where the levees are far back.

When once a river has accustomed itself to a new channel, we know from the river Nile, whose records go back 5000 years, that streams like these raise themselves gradually on their beds very slowly. The Nile valley rises about 5 in. in one hundred years. (The Euphrates has risen about 1½ ft.) So steady is this rise that today if you dig down 24 ft. in the Nile valley and find the foundations of a building you can calculate the number of years at 5 in. for every 100 years, and you can say B. C. 4000 or 5000, or whatever it may be, this building was built here.

ESCAPES

I have considered this problem only to the Atchafalaya escape at the Red River, because below this there need be no difference. This is a very efficient escape which goes into the Gulf of Mexico and is capable of taking away all the excess waters. If a river is carrying 1,500,000 sec.-ft. in flood and a breach occurs on one bank and 500,000 sec.-ft. goes away and that stream, discharging 1,500,000 sec.-ft., suddenly finds itself carrying only 1,000,000, the silt is immediately deposited. But if you have a river capable of carrying 1,500,000 sec.-ft. and it suddenly has 2,000,000 sec.-ft. put into it, I think it is a wise thing to let that extra 500,000 sec.-ft. go down the escape and never enter the channel capable of carrying 1,500,000.

There is no reservoir that you can find for a river so good as one of these open basins on its banks. The river carries its 1,000,000 sec.-ft. and it is within its banks. As it rises above 1,000,000 it overflows not in one place, but in a hundred or a thousand or a million, along its entire length of bank. That kind of overflow does not disorganize the stream, for it leaves the stream in perfect order and relieves it of an excess of water, so that if you make a levee along one bank of the river and let the other overflow you get a moderately increased scour under control, and not out of control, as it is if levees are built on both sides.

We often hear it stated that things are better to-day than they were in 1882, when there was one of the greatest floods the Mississippi has known, because there were 442 breaches then and only nine in 1912. But when the water was only of a moderate height above the country, hundreds of breaches would not do as much harm as one breach when it is 12 or 15 ft. above the level of the country.

To-day a new difficulty has begun to appear owing to raising the water on the levees up to 10, 12, 14 or 16 ft. These are "boils". Where the water is 5 or 6 ft. high on a levee there is no difficulty. But when the water rises it forces its way through decayed trees buried in the soil under the levees, or through holes bored by crabs, and bursts out on the other side like a geyser. Many breaches in the last overflow they say are attributable to this sudden undermining of the levee which no human being could foresee.

So serious has this become to-day on the Mississippi that it is thought it may be necessary to build two levees, one behind the other, which will add many millions of dollars to the expense of this work.

I have often heard it said it seems a pity to allow any land not to be protected by a levee and to leave it open to the floods. But when you consider that out of the 12,500,000 acres in the upper valley, there are only 4,000,000 cultivated to-day and 8,000,000 are still primeval forest, to go ahead and throw up levees to drown out people down below in order to protect a large area of primeval forest is not doing any good to the country, but rather harm.

WHAT THE ANCIENTS WOULD HAVE DONE

With these propositions I shall now go to the question of what the ancients would have done if they found themselves in the valley to-day. The first thing I think they would have done, judging from what I have seen in Mesopotamia, they would have protected the salient bends. They would have taken care that there was no more eating away of levees. There is no use putting up a very expensive levee here and there and letting the river eat it away. Little progress can be made in this way. You are always spending your money in repairing. This point is very well insisted on by the Government engineers and they carry it out to the limit of the growth of the stuff of which the mattresses are made. But more than that might be done now with reinforced concrete at your hand. The stuff of which they make mattresses can only grow at a certain rate, but this reinforced concrete can be made anywhere and you could keep ahead of the damage that is going on in the valley.

All cutoffs would have been allowed by the ancient engineers, according to all their works I have seen. They would never have spent great sums of money to prevent the river from cutting away inside the channel, because it only takes away money and labor from attending to the main object of keeping the two main levees protected. All money spent inside to keep these bends from cutting across is money thrown away.

On the Karun River, in Persia, years ago, the river took an 8-mi. curve and came back again to the same point, and you could see it 4 ft. higher on one side than on the other. They said whenever that is cut through navigation will be upset for a long time. It cut one day and within a week the river was flowing in its new channel and it was difficult to see how it had run around the 8 mi., because it seemed to be so happy in this new channel, just as if it had been there from eternity.

The next thing they would do, I think, would be to calculate what the height of a 2,000,000-sec-ft. flood with 10 per cent added, or 2,200,000 sec.-ft., would be in the valley, and put up profiles from Cairo down to New Orleans to let everybody see what it meant to have water like that clear down the valley. You have had floods, but you do not yet know what it means to have a very high flood without a breach.

RESERVOIRS

Allowing 6 ft. above the bank as not a dangerous height, I calculate that we need reservoirs on the Mississippi which represent 34,000,000 acre-ft. To meet this we have the left hand small basins and the Yazoo and others open at their ends where we have 6,000,000 acre-ft., so we need 28,000,000 acre-ft. to be provided by reservoirs. Reservoirs up in the mountains and in the clouds I don't think would affect the Mississippi. They would be so late or so mismanaged that their influence would never reach the place in the nick of time. We have the St. Francis basin, far cheaper than any reservoir and one of the cheapest in the world, of which three-quarters would suffice for our needs. Let them protect the upper quarter with levees and let three-quarters of the basin be allowed to be put under water, and it would protect the Mississippi River for twenty or thirty years, until the river had widened its channel. In the meantime with transverse dikes from the river to the hills, well adjusted and employed as the ancient Egyptians did theirs, you could let the muddy waters of the Mississippi flow over this basin so that the lands would be greatly improved, and when the time came for the owners to enter into possession they would be much richer than they are to-day.

If you build reservoirs up in the hills or build a dam across the valley, you must first have extensive openings in it so that the waters may traverse it in order that it may be empty when needed. If it is full of water when the rain comes it will be useless. Hence these reservoirs provided for flood protection cannot be used for supplying power or rendering aid to navigation.

Moreover, what is the use of protecting 19,000,000 acres in the Mississippi valley with levees, when only some 4,000,000 are cultivated and the rest is primeval forest and there is neither population nor money to reclaim it?

The people of the Mississippi valley for many and many a year have been rightly nervous, and advantage is being taken of this nervousness for everyone with a panacea to go shouting that something must be done at once.

[The second part of Sir William Willcock's paper deals with the flood situation in the vicinity of Pittsburgh. This part will appear in an early issue.—EDITOR.]

Cutting Down Old Swing-Span Bridge with Blowpipes

Jackson Street Bridge Superstructure in Chicago Was Removed in Twelve Days with Acetylene Torches

THE superstructure of the old Jackson Street Bridge over the Chicago River, at Chicago, was removed in twelve days by cutting it apart with blow pipes and swinging the parts onto barges by a derrick boat having a 60-ft. steel boom. The old bridge, built in 1888, had a three-truss swing span, 280 ft. long and 58 ft. wide. Its east arm spanned the navigable channel of the river, and the west arm spanned team driveways and freight tracks, beneath which was a by-pass to give the necessary flow capacity to the river. The removal of this by-pass to make room for the new bridge had been decided upon in order to give a greater width of channel, as required by the U. S. Government.

Close to the west side of the old center pier is located the new west abutment, and work has been commenced on its foundations. The cofferdam consists of single steel sheet piling with heavy timber bracing, but the weight of the adjacent center pier, swing span and the west retaining wall of the by-pass made it impossible to maintain watertightness when excavating within the cofferdam was started. It was, therefore, considered better to remove the old bridge at once rather than to reinforce the cofferdam at considerable expense.

Investigation showed that the two high brick buildings built on pile foundations on the east side of the river at Jackson Street must be placed on caissons resting on the bed rock before it would be safe to put in the east bridge pier. The delay on the contract due to the sinking of these caissons under the buildings threw the removal of the old superstructure of this bridge into the season of navigation, while according to the contract and original plans this span was to be removed in the winter time.

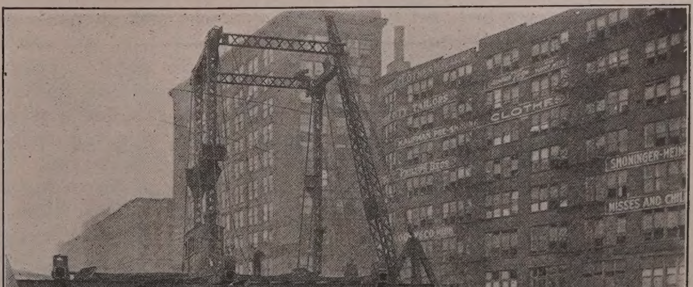
The cutting was to have been done with the Great Lakes Dredge & Dock Company's floating electric welding plant, which is provided with electric arcs for cutting as well as for welding, but at the time this superstructure had to be taken down, May, 1914, this welding plant could not be spared from its regular repair work on the fleet of dredges, tugs, etc., in the Chicago Harbor. It was, therefore, decided to do the cutting with blow pipes. Another point of importance was to avoid all delays to navigation. The current in the river at this point is about 3 miles per hour.

ORDER OF REMOVAL

The bridge, which weighs about 600 tons, was swung to the open position and the flooring torn up. The stringers were first cut away with the blow pipes and then the floor beams were removed. The chords and diagonals were cut near the panel points and the severed sections swung onto barges by the derrick boat. Work was done from both ends so as to keep the remaining part of the structure in balance. No false work was used. It was necessary to maintain a nice poise, as the truss action of the remaining members was much impaired. One of the photographs shows one of the top chord sections of the center panel of a side truss being held by the derrick while a man is cutting it loose at the farther end with a blowpipe. This view also shows the severed sections of the three bottom chords with one of the plate-girder floor beams resting on the turntable. The small cabin in line with the center truss is the operator's house, the bridge having been operated by electricity.

Girders and members were cut mainly in 16-ft. lengths for removal, and they will later be cut in 5-ft. lengths with blow pipes for charging to furnaces as scrap. The thickness of members cut varied from ¾ to 3 in., and where parts overlapped the thickness was as much as 6 in. Different types of blow pipes were used, the Ox-Weld, the Davis-Bournonville, the Engineering Sales Company and the American Boiler Welding Company, but most of the work was done with those manufactured by the Oxweld Acetylene Company. Not more than two

Bridge in Open Position Previous to Cutting of Steel


View Showing Method of Handling Sections After Cutting

operators were engaged in cutting with blow pipes at any one time. The entire work occupied twelve days, including the removal of the turntable, leaving the masonry pier bare.

It is believed that the acetylene torch or burner has some advantages over the electric arc in cutting steel work, in that it cuts a narrower groove and it is more easily manipulated.

ALTERNATIVE METHODS

In regard to removal by other methods it is estimated that it would have taken at least four weeks to cut off rivet heads, drive out rivets and chip or cut the members into the necessary lengths. In this case also there would have been required a greater amount of equipment in the way of air compressors, air hammers and chisels and other tools with more laborers and operators, while there also would have been a greater amount of work in handling the parts by the derrick boat.

The new bridge will be a double-leaf trunnion bascule structure of the Strauss type with deck trusses, having a span of 202 ft. 3¼ in. center to center of trunnions and 182 ft. center to center of front bearings, while the clear width of channel will be 168 ft. The bridge will have a 37-ft. roadway and two 13-ft. sidewalks. The substructure will include two masonry abutments, each supported on four concrete piers sunk to rock at a depth of 90 ft. below datum. The contract for the superstructure was let to the Strobel Steel Construction Company, and the contract for the substructure to the Great Lakes Dredge & Dock Company, both of Chicago. The substructure contract included the removal of the old superstructure and substructure.

NO MORE POLLUTED WATER will be used for drinking or cooking purposes aboard any vessel in traveling from one United States port to another, if an amendment recently incorporated in the interstate quarantine regulations is observed. The new law, which was inspired by investigations of the Public Health service, states that all ships conforming with these conditions shall not furnish for these purposes water taken from any harbor or from any other place which may have been contaminated by sewer discharges. The maximum penalties attached to disregarding the law are $500 or imprisonment for one year, or both, at the discretion of the United States district court.

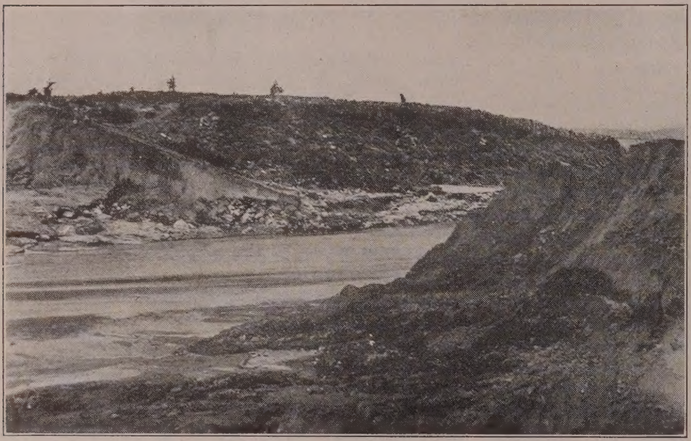
Break in Hatchtown Dam

Earth Embankment in Utah Is Washed Out After Seepage Had Been Detected at Downstream Face Near Outlet Culvert

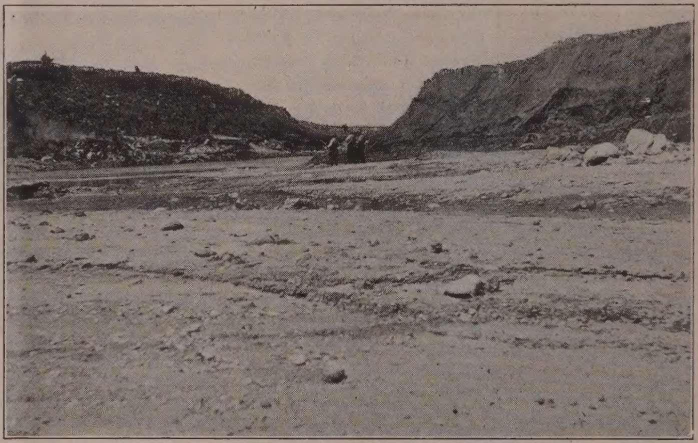
By JOSEPH JENSON
Salt Lake City, Utah

FAILURE of the Hatchtown dam, the earth embankment 60 ft. high, built in 1907 and 1908 by the State of Utah to impound water from the Sevier River for the irrigation of 6000 acres of land, occurred on May 25, after a stream of muddy water had been observed issuing from the rear of the dam along the east side of the outlet culvert. Three hours after the break the entire reservoir, holding 13,000 acre-feet, had been emptied.

The dam was built in Garfield County, Utah, at a point about 1¼ miles south of the little town of Hatch, from which the dam derived its name. The up-stream slope of the embankment was 2 on 1 and down-stream slope 2½ on 1. The regulating works consisted of a heavy stone masonry culvert, a double reinforced concrete gate chamber, and a stone masonry shaft containing the lifting rods and hoisting mechanism, and an 80-ft. wide spillway over the hill on the east. The general features of the design are shown in the plan and cross section.



Close View of Break in Dam



View of Break from a Distance

HISTORY OF DAM

Private parties had, some years previously, constructed a small earthen dam on the same site, which was doomed to failure shortly after its completion. A portion of the embankment of this earlier structure was still in place when the State of Utah undertook the construction of the Hatchtown dam. Some borings through this embankment, and also in the river bed below, revealed a structure of variable thickness, ranging from 2½ to 8 ft. of fine gravel and sand. Below this there was a layer of hard clay and gravel of unknown depth. Excavation was made through to this "hardpan" crosswise of the river bed for the puddle core and lengthwise for the outlet culvert foundation. The west bank of the river up to an elevation of about 50 ft. consists of a fairly well compacted gravel overlaid with a lava capping from 4 to 10 ft. thick. The east side of the river consists of a stratified sand and gravel hill. Over this the spillway was constructed with two deep concrete cutoff walls extending down to firmer material.

Between the lava capping and the gravel on the west, and indeed down into the gravel almost its entire slope, seepage water oozed out in considerable quantities. The source of this water was from the irrigation of a considerable area of farm land on top of the bench, and some distance farther west. This water was concentrated by trenching, and let out at the lower toe of the dam by means of common tile drain pipe. One line of tile drain pipe was laid, also, from just below the puddle core to the lower toe of the dam along each side of the culvert, each conveying a small stream of water to the river below. The fill in the dam was done in the usual way by hauling in the material with teams, wetting and tamping in place.

The following paragraph is copied from the official report of the State Engineer for 1909-1910, page 168:

"At the beginning of the irrigating season of 1910, there was stored in the reservoir very nearly its full capacity of water. Under the pressure thus produced a slight seepage occurred at the east end of the dam. This seepage saturated the material at the lower toe of the dam, causing some sloughing at that place. A heavy bank of rock was piled against the slope of the dam along the line where the sloughing occurred while the water was still at its maximum height in the reservoir and the sloughing tendency was entirely checked. Thereafter the dam stood the test of its first season of service in an entirely satisfactory manner."

CESSATION OF SEEPAGE

The following year, 1911, storage was begun in October, and the reservoir completely filled during the succeeding three months. Two 12-in. flash-boards were placed in the spillway, and the water rose to within 5 ft. of the top of the dam and subsequently descended to the elevation of the spillway sill, remaining at that point till May or June, when it was released for irrigation. Each subsequent year, 1912 and 1913, the reservoir was filled early and the water held until required for irrigation. After the first seepage and sloughing the dam showed no indications of weakness. The seepage at the east end had prac-

Hatchtown Earth Dam Before Break Occurred

tically ceased. This year, on account of the heavy snowfall in the mountains, it was deemed unnecessary to begin storing water in this reservoir until April, and the reservoir was barely filled to its capacity when the break occurred on May 25.

MANNER OF BREAK

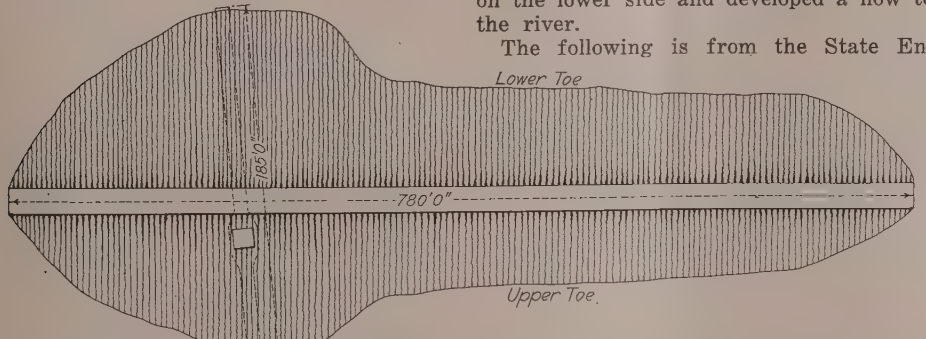
The following paragraph is substantially the oral account of the break as given by A. W. Huntington, watchman on duty at the dam, to State Engineer Beers and the writer on May 30:

Mr. Huntington declares that he was at the identical spot where the first indications of a failure occurred sometime during the forenoon of the day on which the break occurred and is absolutely sure that normal conditions prevailed at that time. About 2 p. m. his attention was called to a stream of muddy water issuing from the rear of the dam along the east side of the outlet culvert. This stream seemed to be well defined and about as large as a common stove pipe. This continued without apparent increase for fully two hours. Then the ground above it began to cave off, first in small flakes, then larger and larger until the back of the wall was about 30 ft. high and probably 40 ft. wide. The larger flakes filled up the cut below, causing a few minutes' cessation of flow till the water backed up and again ran down, carrying the caved off material with it. This action continued more and more rapidly until the gorge had reached the crest of the dam when quite suddenly the whole of the remaining wall fell, making a clear opening to the impounded water above. One peculiar incident which he notes and insists upon is that the tile drain continued to discharge its normal amount of clear water as long as it was possible to observe it.

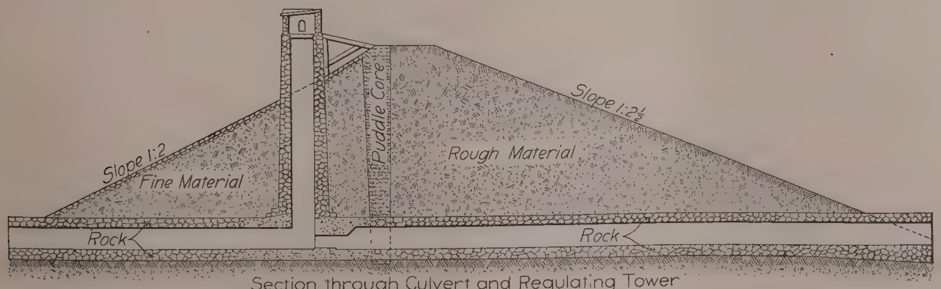
CAUSE OF BREAK

Practically the entire body of the stored water, amounting to about 13,000 acre-feet, lay within 1½ miles of the dam, and being 52 ft. deep at the dam, was released with a mighty rush. The entire reservoir was drained in less than three hours.

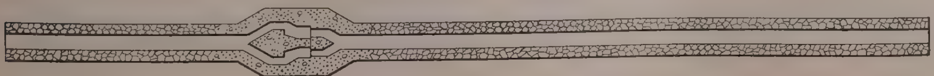
The immediate cause of the break may never be positively known. The only plausible reason that the writer can assign after a careful examination of the premises after the break and from a pretty thorough knowledge of the construction and later behavior of the dam, is that the seepage water from the west hill saturated that part of the dam to the danger point. As already stated, at the time of construction the seepage was concentrated and led from the dam area by drain pipes. At the time of the examination subsequent to the break a new seep or spring hole was observed in the west hill at an elevation of about 40 ft. above the stream bed, which flowed perhaps 0.25 sec.-ft. of water. This spring was on the opposite side of the stone culvert from which the break occurred and distant about 100 ft. It is possible that this water caused a line of saturation downward and outward in the fill until it reached and overflowed the crest of the culvert. The culvert was 13 ft. high, and this seep over the top would probably spread lengthwise of the culvert, until it reached the edge on the lower side and developed a flow to the river.



Plan



Section through Culvert and Regulating Tower



Horizontal Section through Culvert

Hatchtown Dam Showing Type and Location of Outlet Conduit

The following is from the State Engineer's report for 1907-1908 on the Hatchtown Dam:

Cost of reservoir site and water rights...	$5,381.00
Engineering, superintendence and general expense	5,460.97
Property purchased	422.58
Contractors' estimates	73,118.23
Total............................	$84,382.78

The damage to property below the dam due to the flood has not at this writing been determined with accuracy, but may be conservatively stated to be within $100,000. The larger portion of this damage is the result of covering with gravel and other débris certain tracts of farm land along the course of the river, covering with finer deposits of silt growing crops and washing away farm buildings and fences. Sufficient time was given before the flood to warn all people in the path of its course to seek places of safety, and to get cattle and other farm animals out of the way, so that no human lives were lost and not more than a score of farm animals perished in the flood. The State officials have already taken action toward the reimbursement of all parties damaged.

First Operating Plan for New York Barge Canal

THE first definite plan for the operation of the New York State Barge Canal has been put forth by the New York & Buffalo Steamship Company. The company proposes to handle package freight only, running express boats and locals, and making time that will allow it to compete with the railroads. Consideration was given to both the fleet system and the unit system, and the latter was decided to be preferable. In other words, rather than a series of barges towed by one power boat, the company chooses a shallow self-propelled boat as large as can conveniently and safely pass through a lock.

It is proposed to build thirty of these boats. They will be of steel construction, 275 ft. long and 40 ft. wide, with 8½ ft. depth of hold. (The usable dimensions of the locks are 310 ft. and 45 ft., while the minimum width of the canal prism is 75 ft. at the bottom.) Loaded, the boats will draw 6 ft. They will have a capacity of about 2600 tons each, and also accommodations for a few passengers. They are expected to develop a speed of 8 miles per hour. With due allowance for stops and for passage through locks it is estimated that the trip from New York to Buffalo can be made in less than five days.

The preliminary design for the boats was made by Cox & Stevens, of New York City, who are now working out the details. Hamilton & Chambers, also of New York City, have been awarded the contract for building the boats, six of which are to be delivered this year. The company has not as yet definitely determined the motive power. The first two boats will run by steam, with ordinary reciprocating engines. Other types will probably be tried on later boats.

Stockton Street Tunnel

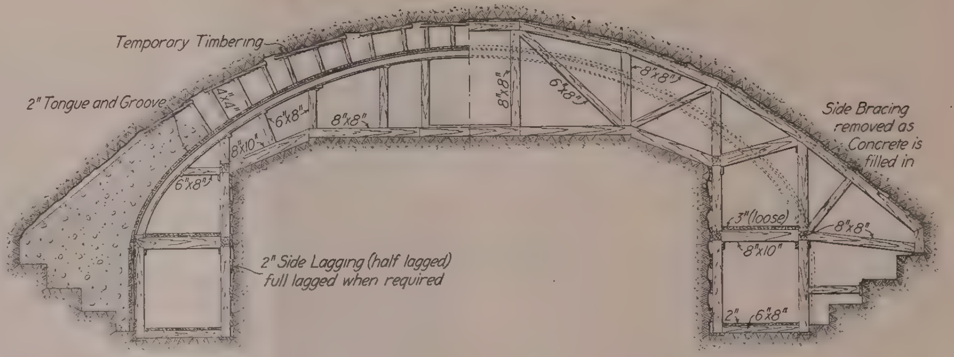
First of a Series to Be Driven at San Francisco to Eliminate the Heavy Grades for Vehicular Traffic Over the Hills

STOCKTON STREET tunnel, San Francisco, is the first of a series of bores by which the city proposes to open streetcar and vehicular traffic and pedestrian thoroughfares where the distances under the hills are not excessive. Funds for the work are obtained by assessment of the property benefited by the construction. The assessment districts for each tunnel are determined by the city engineer or appraisers acting under his directions. The amount levied against any property is determined by its location as well as its area. The tax per square foot varies according to the proximity to the portals, the direction of traffic and any other local conditions that tend to influence the probable increase of property value.

Motor Truck Serving Steam Shovel

The length of the completed Stockton Street tunnel will be 911 ft. from portal to portal, with approaches 137 ft. in length on the north and 275 ft. on the south.

There are two types of reinforced-concrete lining, as shown in the drawings. The lighter is used immediately adjacent to the portals. The specifications for concrete require 1 cu. ft. of cement to 2¼ cu. ft. of sand, with sufficient mortar to fill completely the voids in the broken rock. The exact proportion of rock is determined by laboratory test. To render the concrete waterproof, 30 lb. hydrated lime are mixed with each cubic yard of concrete. The lining is provided with expansion joints at intervals of 50 ft. These joints are made of 1/32-in. copper plate bent to the size and shape shown in one of the drawings, and filled with asphaltum flush to the inside and outside of the arch.



First Stage in Excavating and Timbering Stockton Street Tunnel

For forms and falsework the greatest permissible fiber stresses per square inch are as shown in the accompanying table. The columns are reduced by Gordon's formula:

ALLOWABLE STRESSES IN POUNDS PER SQUARE INCH

	Bending	Compression	Tension	Shear	
				Across grain	With grain
Oregon pine..	1,600	1,200	1,000	1,000	200
Fir	1,200	1,000	850	750	175
Steel	20,000	16,000	20,000	..	12,000

CONSTRUCTION

Excavation for the approaches was in a clay shale formation, which was readily handled by a steam shovel. Blasting was unnecessary. The excavated material was hauled in 4-yd. auto trucks a distance of 2¼ miles. Ten trips per day of eight hours were made by each truck. The cost of excavation and disposing of material was approximately $1.45 per cubic yard.

The south approach, as above noted, is 275 ft. It was found more economical, however, to continue the open cut for an additional distance of 131 ft., construct the lining, and then backfill over the extrados to the required grade of the street above the tunnel.

On neither heading is the entire sectional area excavated at one time, but three drifts each 6 x 6 ft. are first cut for the entire length of the tunnel. Between these drifts only enough material is next stoped out to permit proper timbering. The central core is later removed by a steam shovel, after the concrete lining has been placed and firmly set. Stulls of concrete carry the weight of the roof to an 8-in. I-beam bent to the curve of the intrados, as shown. The advantage claimed for concrete over wooden stulls is that the former need not be removed when the overbreak is being filled with concrete, and the danger of a cave-in is thereby reduced.

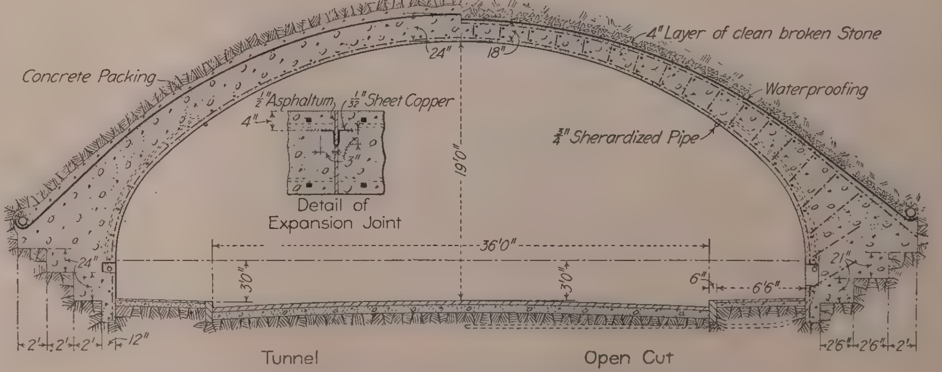
Excavated material is removed from the drifts in small mine cars hauled by a small electric locomotive provided with two 17½ hp motors, supplied with a current of 250 volts. On reaching the open cut these ascend an incline and empty into bunkers beneath which the auto trucks receive their load.

Concrete is conveyed into place from the mixers through pipes. It is moved with compressed air supplied by a 200-hp compressor. Air for the pneumatic drills is taken from the same source.

At the south portal of the tunnel is an eight-story brick building known as the Hotel Victoria. The tunnel undermined the west foundation of this structure and it was necessary to support the same on screwjacks while a brick foundation was erected beneath it. This was done successfully without perceptible settlement.

The Jacobsen-Bade Company is constructing the tunnel for a contract price of $337,000. An additional $38,000 will probably be spent for extras. Tracks will be laid through the tunnel for the municipal railway under separate contract. L. T. McAfee is resident engineer in charge for the city.

COST OF UNLOADING GONDOLA CARS was materially decreased at the Aberdeen, S. D., sewage disposal works according to W. G. Potter in a paper on the plant presented recently before the Western Society of Engineers, by rigging up a block and tackle so that a drag scraper could be pulled lengthwise of the car, dumping at the end over a trap into a Koppel industrial car beneath. The material was 175 car loads of broken stone for the sprinkling filters. By hand the work cost 45 to 65 cents per yard, a figure cut to from 19 to 24 cents per yard. A switch track enabled cars to be placed adjacent to the filters. The total average cost was 32.4 cents per yard. Laborers were paid 25 cents per hour.



Details of Reinforced Concrete Lining and Expansion Joint

Curb Failures at Concrete Crossings

Damage Done by Expansion and Contraction of Sidewalks in Chicago Suburb and Discussion of Remedies

By JOHN BERG
Chicago, Ill.

SUBURBS of our large cities are paying their share of the cost of experiments with sidewalks and sidewalk contractors. Concrete is yet in its infancy and few people know its whims and its caprices, but a good many are using the material as though its properties were well known to them. The contractor may be a typical real estate promoter, ignorant of proper construction methods, or the community may not be large enough to get the best engineering supervision over its sidewalk construction. This combination furnishes splendid opportunities for poor results; and evidences that they have been taken advantage of are plentiful.

Of all communities imposed on in this manner perhaps none has fared much worse than Austin, Chicago. Many cement sidewalks were laid about ten or twelve years ago in this splendid residential section. The sidewalks themselves are in a pretty good state of preservation, but at many street intersections the flagging or curb, whether concrete or stone, is no longer in its original alinement where the sidewalk comes up against it. In a large number of cases the curb has been damaged by some force coming from the direction of the sidewalk.

PROBABLE CAUSES

Where the sidewalk was built close up to the curb the failure of the latter is undoubtedly due to the expansion of the sidewalk concrete in warm or moist weather, but there are failures of the curb in a good many places where the sidewalk has not been in apparent contact with the curb. Usually, however, close examination will show that the sidewalk builder has not been careful about keeping the concrete away from the curb line at the foundation of the sidewalk. Where the proximity of the concrete in the sidewalk foundation is not to blame for the failure it may be explained by the expansion due to freezing of moisture held in an intermediate earth layer, which is usually pretty well puddled.

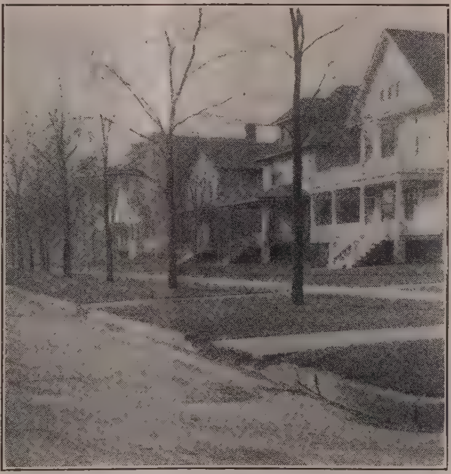
Photograph 1 illustrates the condition at a sidewalk crossing on a residence street in Austin. Here the curb has been "kicked out" by the sidewalk, apparently years ago, and the pieces have been removed. The second failure in this same picture shows that it is not the higher frequency of pedestrian traffic that causes the damage at the crossings. The cause is either inherent in the sidewalk itself, the material it is made of, or the design and manner of its construction.

MOVEMENT OF SIDEWALK

Where the curb is of bluestone or equally resistant material we have the condition faithfully represented in photograph 2. The curb has not been carted away at this point but it might as well have been, for the street could hardly have made any worse appearance than it now does at this corner. Here there has been a movement of the sidewalk of at least 2 in. If nature is allowed to proceed uninterruptedly I should say that in ten years from now the photographic plate will show the edge of the sidewalk in line with the street edge of the curb instead of on the center line of the curb as at present.

Photograph 3 represents a familiar sight in the more newly built-up section of the district. In another five years, perhaps two or three years, a portion of the curb will be carted away at this place, and the crossing will look like that in photograph 1.

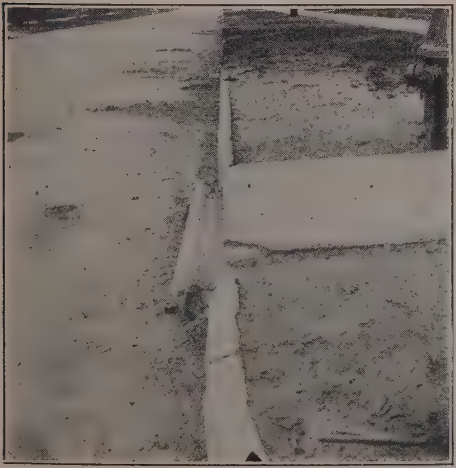
Photograph 4 shows a sidewalk crossing in the most recently built-up neighborhood in this district. This illustrates a laudable effort at improvement in sidewalk crossings at curb lines, but even this arrangement does not stay put. The sidewalk is already overhanging the gutter about 1 in., and in ten years from now there will be quite a little overhanging shelf, when the street sweeper will have a good deal of difficulty in keeping this gutter clean.

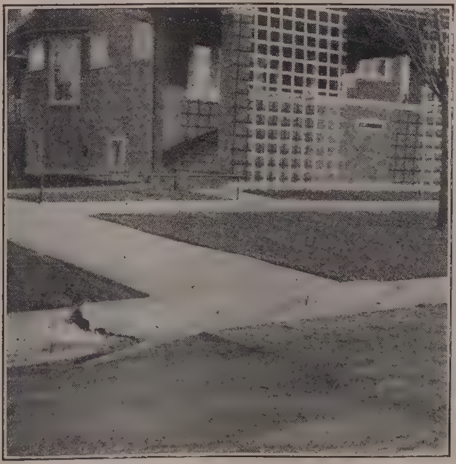

1—Damaged Curb on Residence Street

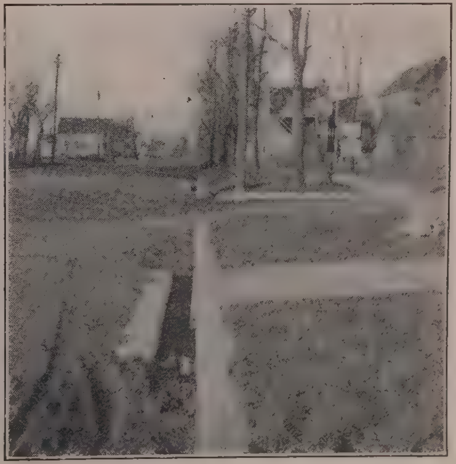
It is not the fault of the concrete; expansion and contraction are well-known properties of concrete as well as of stone. Bluestone sidewalk slabs, with joints plastered with cement mortar, have been known to pitch up to an angle on a very hot day, as shown. Expansion, however, does no damage in the middle of the block, for with a fall in temperature or decrease in moisture the slabs fall back on their original bed. Not so with the sidewalk slabs near the end of the walk as at the curb line. If the sidewalk is built up snug against the curb no ordinary construction of the latter can stop the sidewalk during its expansion. The slab nearest to the curb moves the greatest distance, the next one doesn't move quite so much, the third moves still less, and so on. The curb having failed there is no reacting force, and when temperature and moisture conditions are favorable for contraction the slabs are not forced back to their original locations, but contract towards the centers of their recent supporting areas, thus leaving small openings between the sidewalk slab nearest the curb and between the slabs themselves as far back as forward movement has taken place. These openings fill up with dirt and sand. As conditions again become favorable for expansion the sidewalk pushes the curb a little farther into the street.

EXPANSION JOINTS

The remedy lies in provision for expansion between the slabs near the curb, and an especially efficient expansion joint between the curb and the nearest slab. In addition thereto the curb should have some reinforcement at this point. A few vertical rods, costing but a few cents, would probably continue to keep the curb in place even though it should be ruptured through expansion of the sidewalk slabs. As a general thing displacement of the slabs is visible only on the outside of the intersecting walk. It would seem unnecessary, therefore, to provide for expansion inside of the intersecting walks except, perhaps, wehre there is no parking and the two sidewalks are close to their respective curblines.


2.—Movement of Sidewalk Slab


3.—Crack in New Concrete Curb


4.—Overhang of the Sidewalk

Engineering Features of the Panama-Pacific International Exposition

Part III—Systems of Water Supply for Fire Protection and for Domestic Consumption and Use of Automatic Sprinklers in Buildings

By A. H. MARKWART
Assistant Director of Works

ACTING with the advice of the special committee on fire prevention of the National Board of Fire Underwriters special attention has been given to the matter of fire protection in general throughout the grounds of the Panama-Pacific International Exposition to be held in San Francisco next year. The high-pressure water system is designed to allow for sufficient pipe size to deliver 15,000 gal. of water per minute over an area of 100,000 sq. ft. under a running pressure of 200 lb. per square inch at the hydrant. This pressure will be maintained in the most remotely situated points of the main group of buildings. It is possible that a higher pressure will be realized at points on the grounds nearer the source of supply.

High-Pressure System

This system will be connected with the auxiliary water-supply system of the city and county of San Francisco at two points on Van Ness Avenue and will be essentially a part of that system, obtaining its supply from the Twin Peaks reservoir at El. 756. The highest ground elevation on the site is 82 ft. and the lowest is —2 ft. The system under normal conditions will be operated at an average static pressure of 200 lb. per square inch from the Ashbury Heights tank at El. 462. In addition to the connection with the city system there will be two fireboat connections provided on the exposition waterfront, so that the two available municipal fireboats, when necessary, may pump salt water direct into the exposition's system. The capacity of each of these fireboats is 10,000 gal. per minute at 150 lb. pressure and 4500 gal. per minute at 200 lb. pressure per square inch. Normally, however, the system will contain fresh water.

To avoid the unsightly appearance of hydrants the system is provided with flush hydrants located directly over the mains. These hydrants are spaced approximately 300 ft. apart and have two 3-in. outlets with standard San Francisco fire department hose connections. A typical detail is given herewith, showing completely the design.

The exposition high-pressure distributing system is composed of 6, 8, 10, 12 and 16-in. lap-welded, asphalt-dipped, steel pipe, all steel sleeve couplings and extra-heavy cast-iron flange fittings with necessary gate valves to sectionalize the system adequately. All pipes and fittings will be subjected to a shop test of 500 lb. per square inch and a field test of 450 lb. per square inch.

Connections to each building from this system will be by means of 8-in. extra-heavy screw pipe, one connection being provided on each of the four sides of every building. In this way a supply and perfect circulation will be assured for the floor and roof hydrants, roof monitors, automatic and cornice sprinkler system.

Endeavor has been made to keep all buildings separated by a distance of not less than 130 ft., except where buildings, particularly in the main group, are joined together by architectural connections. In the courts of the main group the requirements of the architecture were such as to demand a continuous façade around the several sides of the court. In such cases there was interposed a fire wall of reinforced concrete at the ends of the connections.

Automatic Sprinklers

The plans contemplate a complete system of automatic sprinklers for all of the main group of buildings. The detached buildings, however, will not be so equipped, as it was thought that such protection was unnecessary, particularly in the case of Machinery Hall, which was very high, and in the case of the Fine Arts Palace, which was fireproof. In addition to the automatic sprinklers there will be provided open cornice sprinklers for creating water curtains on the building façade in the event of fire. These open cornice sprinklers will be provided on all buildings where the distance between buildings is 150 ft. or less. Not being automatic, the control valves will be arranged in such a manner as to make them easily accessible.

The high-pressure and domestic water-supply systems will furnish primary and secondary fire protection respectively. Primary fire protection will be available in the concessions, main exhibit palace and State and foreign districts. Secondary protection is to be provided throughout the grounds. The primary water supply will be for fire purposes only.

All buildings will be equipped with 3-gal. chemical hand extinguishers based on one extinguisher for each 3200 sq. ft. of floor area, and in addition the requirements imposed by the rules and regulations call for each participant to supply one hand extinguisher for each 2500 sq. ft. of floor occupied by him. Further, each main exhibit palace will be supplied with at least one 33-gal. wheel chemical fire engine equipped with at least 50 ft. of hose.

The primary and secondary water supply will be brought within all of the main exhibit palaces. From the secondary system will be taken sufficient standpipes, to which will be attached equipments of 75 ft. of 1½-in. unlined linen hose so that all parts of the floor area can be reached with at least one stream. From the primary system will be taken floor and roof hydrants and monitors. All high-pressure roof hydrants will be equipped with 150 ft. of 2½ in. cotton, rubber-lined hose, which will be operated only by the exposition fire department. Monitors will be installed in suitable positions on the building roofs so that 2-in. streams of water can be thrown inside and outside of the building and on neighboring structures.

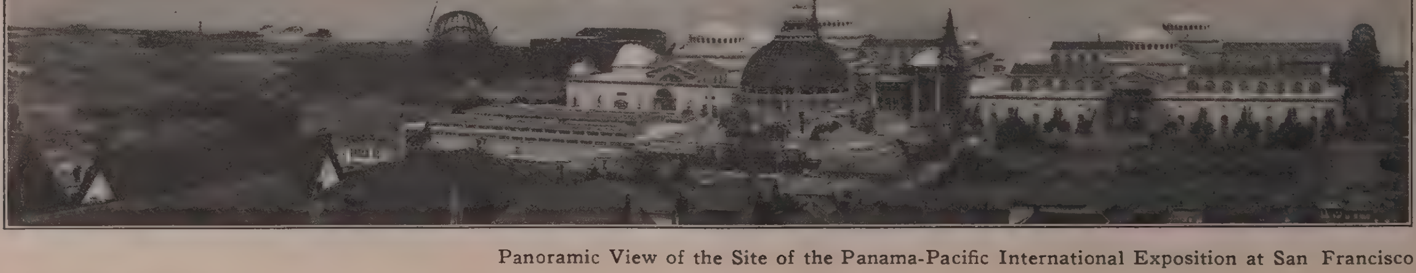
Fire-Fighting Apparatus

The exposition will provide a fully organized and equipped fire department with all necessary fire-fighting apparatus, as well as an organization of guards to police the property. It is probable that the exposition guards will be formed of a special detail of United States troops. This will undoubtedly have much to do with producing a well-disciplined organization which, with the exposition fire department as a branch of the city of San Francisco fire department, will provide ample protection against possible fires, accidents and thefts.

The present plans contemplate at least three completely equipped fire-engine stations in advantageous places throughout the grounds. Movable equipment will be motor propelled and will consist of three hose wagons, three motor pumping engines, two ladder trucks, a squad wagon and a chief's car.

The fire-alarm system will be provided with fire-alarm boxes conveniently located. All circuits will be carried underground to headquarters, from which alarms can be transmitted over separate circuits to various fire stations throughout the grounds. Connection will be provided with the San Francisco central office, so that a general alarm can be transmitted in the event of a serious conflagration.

Based upon detailed calculations, the assumption has been made that the maximum fresh-water demand will amount to 3,500,000 gal. per day, with a maximum rate of flow of one and one-half times this

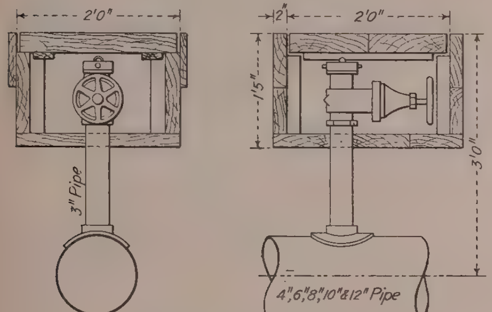


Panoramic View of the Site of the Panama-Pacific International Exposition at San Francisco amount. The fresh water will be furnished the exposition company by the Spring Valley Water Company from a neighboring reservoir situated at an elevation of 135 ft. Connections with the water company's mains will be made on Van Ness Avenue, at the extreme eastern end of the concessions district. The pressure available from this reservoir is insufficient, and the present plan contemplates the installation of a booster pumping station in the concessions district near Van Ness Avenue to raise the pressure sufficiently to establish not less than a 50-lb. pressure at the street curbs under normal conditions. In addition to this reservoir, which will be virtually attached to the exposition system, it is planned to make use of an existing 500,000-gal. reservoir in the Presidio. This reservoir, suitably situated, will be connected to the westerly side of the distributing system and will establish a constant pressure on the system.

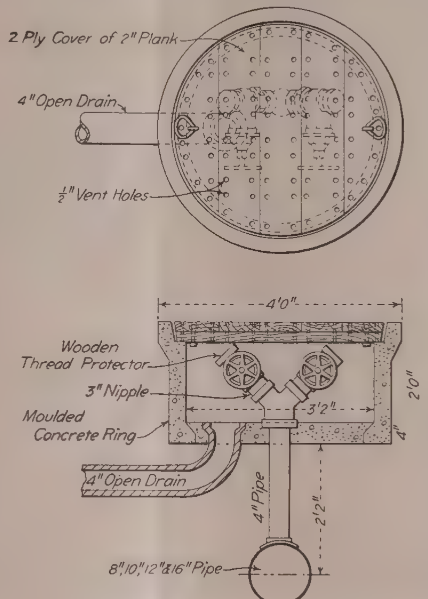
The domestic water-distributing system comprises 4, 6, 8, 10 and 12-in. pipe manufactured by the National Tube Company. These mains will, in general, parallel the mains of the high-pressure water-supply system, so that secondary and primary fire protection will be available in all parts of the districts covered with buildings. All pipes and fittings are coated with an asphalt composition which will afford sufficient protection for the time required.

All fire hydrants taken from this system are located directly over the mains and inclosed in wooden manholes. The hydrants are single 3-in. San Francisco standard outlets and are located approximately 400 ft. apart. Motor pumping engines of the exposition fire department will draw from the low-pressure hydrants as exigencies may require. Pipe sizes are sufficiently large to permit of a draft of 3000 gal. per minute in this manner in addition to that required for ordinary domestic purposes.

All main exhibit palaces will be connected to the domestic water-supply system by means of 6-in. pipes on each side of the building, from which the building will be supplied with water for domestic service and to which will be attached the low-pressure standpipes and small hose equipment. In all buildings cross-connections between the high and low-pressure water systems will be provided in such a way as to provide the automatic sprinkler systems with both primary and secondary supply.



Sections of Low Pressure Hydrant



Plan and Section of High Pressure Hydrant

Details of Fire Hydrants for High and Low Pressure Systems

YELLOW-PINE SPECIFICATIONS, following those of the Isthmian Canal Commission, were adopted by the Georgia-Florida Saw Mill Association May 30. There had been some expectation that the association would adopt the more stringent and logical specifications approved by the board of directors of the Yellow Pine Manufacturers' Association in May, and printed in this journal May 23, page 579. The specifications adopted by the Georgia-Florida association resemble those of the Yellow Pine Manufacturers in that no distinction is made between longleaf and shortleaf pine. They provide for six growth rings between the third and fourth inches from the heart, a greater number of which shall show at least one-third summerwood. Wide-ringed material excluded by this rule will be accepted provided that in the greater number of the annual rings the dark ring is hard and in width equal to greater than the adjacent light ring.

Girderless Concrete Slabs

Proposed Exact Method of Finding Coefficient of Bending Moments of External Forces

By JOHN KRIPPNER
Architectural Engineer, Department of Buildings
Chicago

As has been stated in an article by Ernest McCullough, published in Engineering Record of May 2, there is an urgent demand for an ordinance that would cover the design of flat slabs of reinforced concrete in Chicago. The engineers of the Building Department keenly realize the need for such an ordinance, and in the absence of one they are framing up a ruling which may eventually become an ordinance. As the object of such a ruling, naturally, is safety first, consistent with fairness and impartial treatment of the subject, this article has been written with a view to elucidate some of the principles involved in the theory of the design.

In this article the writer intends to show how the constants of the bending moments due to the external forces may be derived mathematically, by ordinary methods of mechanics and a simple process of integral calculus. To illustrate the method more fully, let us consider in Fig. 1 a square panel of concrete slab separated from the adjacent slab and supported by a column at center. As the panel is assumed to be loaded with uniformly distributed load, there will result a cantilever beam action around the column capital the bending moment of which we wish to find. Considering the shaded portion in the diagram as independent from the rest of the slab for the time being, and assuming the column capital to be two-tenths of the length of side of panel L, we have the bending moment at the edge of the capital:

$$BM = (W/4)\ (L/4.28) = WL/17.1$$

where W equals the total load on the panel.

Again, in Fig. 2, consider the same panel with the shaded portion as shown independent. The load being the same as before, the bending moment around the same capital will be:

$$BM = (W/4)\ (L/3.93) = WL/15.7$$

These two results being different from each other for the same load, it is evident that this method of treatment is not correct. Notice that in Fig. 1 the moments have been taken about a line parallel with the side of the panel, while in Fig. 2 parallel with the diagonal. Any other assumptions similar to the two given will give as many different results, showing the method to be radically wrong. To find an expression for the bending moment that would be true for every point on the circumference

Taken May 26, Showing Buildings Nearly Completed, Nine Months Before Opening Date of the column capital the following method involving calculus must be used.

Consider, in Fig. 3, the same panel as before and only the differential triangle being loaded. The area of this triangle is always $L\,d\,x/4$. The center of gravity is always on the median line, two-thirds of its length from the center of the column. Hence the moment arm of this differential triangle is always $(L/3)\sec\Theta - (L/10)$ measured from the circumference of the column capital. Now if w is the load per square foot of slab, the total load on the differential triangle is $w\,L\,d\,x/4$ and the differential bending moment around the edge of the capital is

$$d\,(BM) = (w\,L^2/4)\ [\sec\Theta/3 - (1/10)]\ d\,x$$

The summation of this expression will be the total bending moment. To integrate this, however, $d\,x$ must be expressed in terms of Θ, which may be done from the relation of x to Θ as shown in the diagram, where

$$x = (L/2)\tan\Theta$$

and consequently

$$d\,x = (L/2)\sec^2\Theta\,d\,\Theta$$

Substituting

$$d\,(BM) = (w\,L^3/8)\ \sec^2\Theta\ [\sec\Theta/3 - (1/10)]\ d\,\Theta$$

and

$$BM = (w\,L^2/8)\int_0^{\pi/4}[\sec^3\Theta/3 - \sec^2\Theta/10]\,d\Theta$$

This expression is easily integrable by means of well-known tables of integrals and results in

$$BM = \frac{w\,L^3}{8}\left[\frac{\tan\Theta\sec\Theta + \log\tan\left(\frac{\Theta}{2}+\frac{\pi}{4}\right)}{2\times 3} - \frac{\tan\Theta}{10}\right]_0^{\pi/4}$$

$$= \frac{w\,L^3}{8}\left[\frac{1.414 + 0.881}{6} - \frac{1}{10}\right] = \frac{w\,L^3}{28.2}$$

(Notice that the logarithm in this expression is a natural log to the base *e*.)

As the last form is the bending moment around 45 deg. of the circumference, the bending moment around 90 deg. is

$$2(w\,l^2/28.2) = w\,l^2/14.1$$

and around 180 deg.

$$2(w\,l^2/14.1) = w\,l^2/7$$

The last form is the total bending moment for the panel fully loaded, at the edge of the column capital, which may also be expressed, since $W = w\,L^2$ equals the total load on the panel.

$$B\,M = W\,L/7$$

which is the coefficient of the external bending moment on the slab at the capital whose diameter is $L/5$.

For different diameters of the column capitals different coefficients will result.

The table gives these coefficients for various diameters assumed and for comparison derived by the two approximate methods shown above and by the exact method, for 180 deg. of circumference.

In monolithic construction it is customary to assume that the positive bending moment in the middle of the beam is one half the negative moment at the support. Hence if the panel above is now considered joined to the floor slab adjoining it, the sum of the positive and negative bending moments must be equal to the total bending moment around 180 deg. of the column capital derived above. Taking, for example, the case when the radius of the capital equals one-ninth of the panel length, we have a coefficient of *WL*/7.4 by the exact method. Therefore the negative moment at the capital is two-thirds of this, or

$$(2/3)\ (WL/7.4) = WL/11.1$$

and the positive moment in the center of panel is one-third, or

$$(1/3)\ (WL/7.4) = WL/22.2$$

As there are always four bands of steel in each panel, the bending moment on each band is one-fourth of the latter, or

$$(1/4)\ (WL/22.2) = WL/88.8$$

These coefficients, then, should be used in designing the steel reinforcement in each band and around the capital, if the steel is assumed to carry all tension in the concrete. As, however, most extensometer tests indicate smaller bending moments than the theoretical ones derived above, it is evident that tension in the concrete plays an important part in assisting the steel reinforcement to carry the bending moments. From the reports of the various boards of examiners that have been appointed to investigate the flat slabs for this building department it seems that a bending moment of *WL*/15 around the capital and *WL*/25 at the middle of the panel may be considered safe practice, when the diameter of the column capital is about two-ninths of the panel length. The difference between these coefficients and those above, then, represents the influence of the tension in the concrete. Whether this is the final solution of the problem or not depends on future developments; but the experience at present seems to show that the last given coefficients are satisfactory and produce reasonably safe structures, and those are the coefficients contemplated in the provisional ruling on flat slabs by the building department.

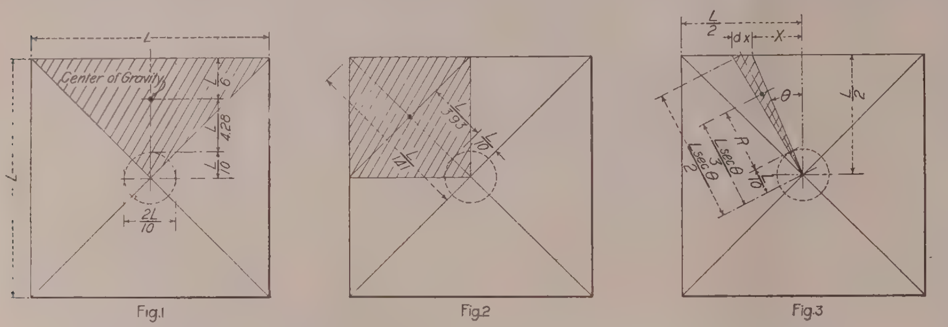


Fig.1 Fig.2 Fig.3

Girderless Slabs Showing Elements Used in Calculating the Bending Moment

Diam. of col. capital	Approx. meth. by Fig. 1	Approx. meth. by Fig. 2	Exact meth. by Fig. 3
0	*WL*/6	*WL*/5.7	*WL*/5.2
L/6	*WL*/8	*WL*/7.4	*WL*/6.7
L/5	*WL*/8.5	*WL*/7.8	*WL*/7.0
L/4.5	*WL*/9	*WL*/8.2	*WL*/7.4
L/4	*WL*/9.6	*WL*/8.7	*WL*/7.8
L/3.5	*WL*/10.5	*WL*/9.4	*WL*/8.4
L/3	*WL*/12	*WL*/10.6	*WL*/9.3

Handling Meters in Minneapolis

METHODS of reading, repairing and handling meters in Minneapolis are given in a recent report by F. W. Cappelen, city engineer, as follows: Of the 47,940 taps in the city, 43,140 are metered. Readings are taken quarterly by twenty-one readers working thirty days—an average of one in six minutes. At the end of each quarter it is necessary to bring to the repair shop about 2000 meters for repairs on account of the meters being stopped, leaking or in some way damaged. From 500 to 1000 which have not been in the shop for a number of years are brought in for testing purposes.

After the readings are finished on the first day on which the bills are due it is often necessary to make 3000 or 4000 verifications. There are places where the bills seem to be too large and have been objected to by the customer. On these a thorough examination of the meter is made in order to find the cause of large bills. Very much cannot be done in the repair line in January during the time in which the readings are made, or until after Feb. 20, when the bills are delinquent.

After the twentieth of the month there are employed three horses and wagons, two men on each wagon, whose duty it is to bring in all the meters that are necessary to bring to the shop for repairs, tests, etc. The remainder of the men, with the exception of probably two or three, who must be utilized for inspections, are put in the shop repairing these meters.

On Aug. 1 there was started a system of bringing in all meters in the city, hoping that within three years all of the meters will have been tested and necessary repairs made. The list of meters to be brought in for repairs and tests is made out in the office from the reading sheets of the inspectors. These sheets are distributed among the various persons in charge of bringing in meters and a sheet is attached to the meter when brought in the shop, with the address, size, make and number of the meter, the reading and the date the meter was taken out. When the meter is repaired, the inspector repairing it states on a card what he did with the meter, what new parts were added, and the time necessary to repair it. The card is brought to the office, the number of the meters, the reading and the house number are compared on the books to make sure that they all agree, and the meter can be returned to the place where it belongs. The card is then returned to the shop with the O.K. of the office on it, the meter is tested, sealed, and returned to the inspector to be set. There is a report made by the clerk in the shop of each meter. These reports are sent to the office every day and the bills for all repairs are then sent out to the consumers.

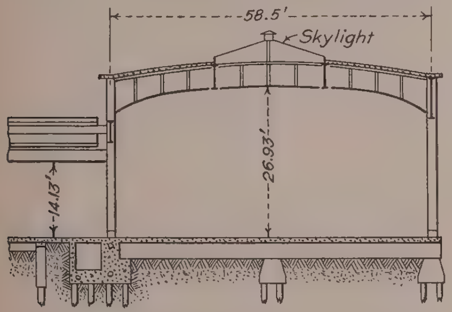
A BASE MAP of New York, described as the most accurate representation of the State ever printed, has just been published by the United States Geological Survey. The map, which has been prepared in connection with work on the great international map of the world, is plotted on a scale of 1 to 500,000 and is believed to show in accurate position all the principal cities, towns, villages, streams, roads and the main political subdivisions. It will be sent in a mailing tube, postage free, upon remittance of 35 cents to the Director, United States Geological Survey, Washington, D. C.

Remodeling Jersey City Passenger Station

Building New Ferry House and Concourse and Improving Old Head House While Maintaining 1200 Train Movements Daily

THE $4,000,000 improvement of the Jersey City terminal of the Central Railroad of New Jersey included, in addition to the reconstruction of the trainshed, described in the issue of May 30, page 622, the removal of the old ferry house, bridges and train concourse, their reconstruction on the same sites and the rearrangement of the lower part of the head house. These operations were more expensive and difficult on account of the necessity of providing for the safety of more than 50,000 passengers and maintaining without interruption more than 1200 train movements daily. Construction was carried on in successive zones while other zones of the terminal were undisturbed or had been rebuilt and restored to service.

The new train concourse, 63½ ft. wide and 220 ft. long between the head house and the train shed, is unobstructed by columns, and is spanned by transverse plate girders carrying the roof. These have a maximum weight of 14½ tons each, and were handled entirely by locomotive cranes with 70-ft. booms, which unloaded them from the cars in single complete pieces and erected them. This operation was made difficult by the awkward positions the cranes were frequently compelled to work in, and the extreme caution necessary to avoid danger to the large number of passengers almost constantly moving between the boats and the trains.



Section through Train Concourse at A-A

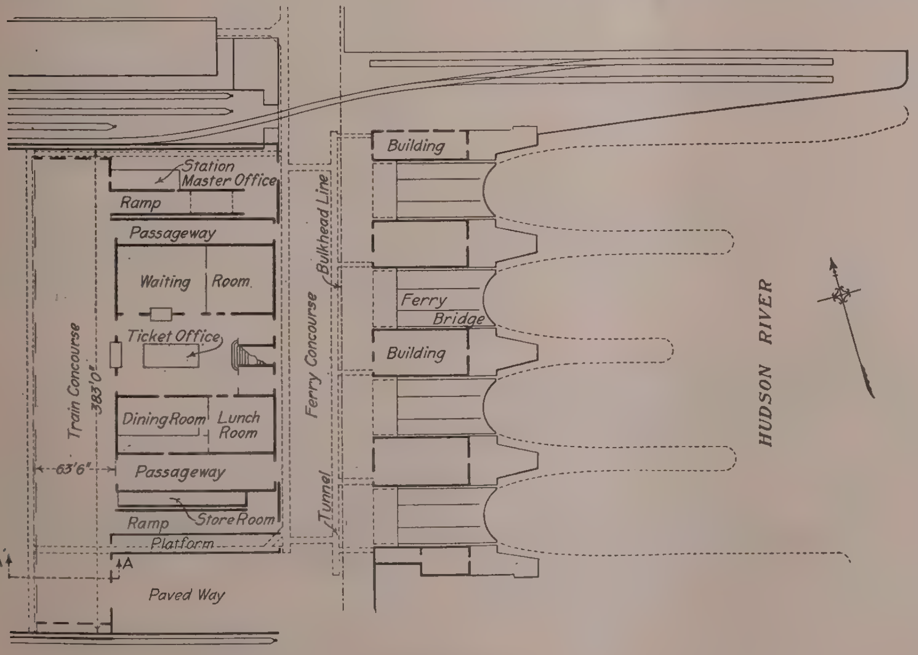
Communication between the trains and the boats was established, first at one point and then at another, temporary fences were built to confine the passengers to spaces reserved for them, and different sections of the concourse roof were successively built until it was entirely completed. While these changes were in progress protection was afforded to the passengers by the use of 15 x 15-ft. roof units supported on four vertical braced wooden posts. These were easily moved from place to place and when set adjacent to each other formed a satisfactory continuous shelter for the passengers to walk under on their way to and from trains.

Ferry House and Slips

The reconstruction of the ferry house, like that of the trainshed and the head house, was effected on the same site without materially interfering with the passenger service. The ferry house was rebuilt in substantially the same location and of the same general dimensions as before, except that the height was increased from one to two stories. The work was done in several sections and as these were completed, the traffic was successively transferred to them and other sections were thrown out of service for reconstruction.

Two temporary slips were first established, one on each side of the old slip. Passageways were provided from them to the ends of the ferry concourse, and the normal number of service boats was operated in these slips and in two of the old ones, thus enabling any other two of the four old slips to be closed for reconstruction.

The two north slips and adjacent concourse were first removed, and new foundations, platforms, superstructure and bridges were built in their place, the construction being effected in several successive north-and-south zones. As each bridge was finished and the corresponding portion of ferry house and racks completed, it was put in service and one of the remaining old bridges with its adjacent buildings and concourse was taken out of service.



Floor Plan of Station and Ferry House

Concreting and Steel Erection

Aggregate for the concrete was brought to the slip in scows and unloaded by a bucket operated by a floating stiff-leg derrick. This delivered to a Lakewood mixing plant with a 1-yd. Ransome mixer and a steel tower 100 ft. high, provided with a double-knuckle system of steel chutes delivering through an area of 120 ft. radius. This plant made the record run of 208 yd. on Sunday, Sept. 21, and had an average efficiency of 160 yd. in one eight-hour day shift, involving a total cost of from 60 to 80 cents per yard for all labor involved.

The steelwork on the ferry house was erected by two entirely different plants. The first or northerly half was placed by a large two-boom traveler running on two short standard-gage tracks on the completed portion of the work, one boom unloading steel from the scow and the other boom erecting. This traveler was found to be slow, awkward and costly, and was discarded on the second half of the steelwork. On this southerly half the inshore steel was put up by a locomotive crane with a 70-ft. extension boom, running on a short piece of standard-gage track located on the walls of a pipe tunnel. The crane took the steel from the lighter and erected it. The steel for the slips and offshore portion of the ferry house was erected by the lighter which delivered it.

Distribution of Concrete from Tower

Head House

The old head house or station building proper is retained, but the first floor is completely rearranged to make it more convenient and efficient. Formerly this floor was divided into three east and west parts; the main waiting room occupied the central part, the south section was occupied partly by the restaurant and partly by trainmen's rooms, and the north portion accommodated retiring rooms, baggage and mail and the station master's office. As the waiting room was directly between the one-story ferry house and the train concourse and opened directly upon them, the morning and evening crowds of suburban passengers passed through it in preference to the out-of-the-way passages on each side of the building.

In rearranging the building it was determined to keep these currents of local passengers out of the waiting room. To a large extent this was accomplished automatically by the widening of the trainshed and the building of ramps north and south of the head house from the train concourse to the second floor of the ferry house. In addition, however, the waiting room was moved into the north section, accommodations being found for baggage and mail in the ferry house, and for the trainmen and station master in a new building north of the north ramp. This released all of the south section for restaurant purposes, and made it possible to convert the old waiting room into a spacious lobby, with an island ticket office in the center and a broad stairway to the second-story concourse of the ferry house. The new waiting room occupies the western part of the north section, and is not in the direct path of passengers going directly from train to boat or vice versa.

On account of difficult traffic conditions for which provision could not be made in advance, practically all of this work was done on a percentage basis. The ferry-house substructure and steel erection were done by G. B. Spearin, the ferry-house superstructure was built and head-house alterations were made by C. T. Wills, Inc., the bridge machinery was furnished by the A. & F. Brown Company, and the conduit work and lighting were done by Westinghouse, Church, Kerr & Company—all of New York. The work, including the trainshed removal and reconstruction, was executed by an average force of from 800 to 900 men, working two shifts part of the time on some of the work, and with a large amount of overtime on all of the work. The average weekly payroll varied from $12,000 to $14,000.

The work was done under the direction of the engineering department of the Central Railroad of New Jersey, of which Joseph O. Osgood is chief engineer, A. E. Owen, principal assistant engineer; J. J. Yates, bridge engineer, and C. M. Tisworth, assistant engineer in charge.

REMOVAL OF SEPTIC TANK SCUM after it has become ripe was advocated in discussion by W. D. Gerber at a recent meeting of the Western Society of Engineers. If the scum is not removed it turns into a leathery gelatinous substance and finally much of the material drops to the bottom and is difficult to remove.

Hell Gate Bridge Superstructure

Longest Arch in the World, Four-Track 1017-Foot Clear Span, 93 Feet Wide and 307 Feet High, with Two-Hinge Trusses 140 Feet Deep

THE most important structure of the New York Connecting Railroad is the Hell Gate bridge now under construction. It will be the largest span of its type in the world and will be of imposing appearance and monumental character, designed with regard to architectural and artistic effect and efficiency of construction.

Important features of its steelwork include the great dimensions and capacity of the span; the type of spandrel braced trusses; the character of main compression members and joints; the system of secondary bracing; the suspended floor platform, and the plan for cantilever erection. The design and construction of the great tower piers, their deep and difficult foundations, and the details of the steel superstructure vary from ordinary construction and will be described in subsequent articles.

The span will have a total weight of over 26,000 tons, equal to 53,000 lb. per linear foot, including about 19,000 tons of high carbon structural steel, equivalent to 38,000 lb. per linear foot. The great weight is due to the heavy loading specified, which provides for full-length or local train loads of 6000 lb. per linear foot preceded by two E 60 locomotives on each track, and for a moving wind load of 500 lb. per linear foot plus a static wind load of 30 lb. per square foot of exposed surface of unloaded bridge.

STRESSES

The statical stresses are increased by impact allowances computed by the Lindenthal formula

$$I = \frac{L^2}{L+D} \times \frac{8\,Q + q\,a}{4\,Q + 4\,q\,a}$$

where I is impact stress; L, live-load stress; D, dead-load stress; Q, weight of locomotives and tenders, and qa, weight of train exclusive of locomotives and tenders. Direct stresses, secondary stresses, temperature stresses, impact, erection and wind stresses are provided for. The distortion stresses were found negligible. The maximum combined unit stress is 24,000 lb. Dead-load stresses were computed partly for a three-hinge and partly for a two-hinge arch and live-load stresses were computed for a two-hinge arch. The required ultimate strength of the steel is 71,000 lb. with minimum and maximum of 66,000 and 76,000 lb. The minimum elastic limit is 38,000 lb. per square inch, and an elongation of about 20 per cent is required. Either acid or basic open hearth steel was acceptable and the former is used with a maximum of 0.06 per cent phosphorus and 0.05 per cent sulphur.

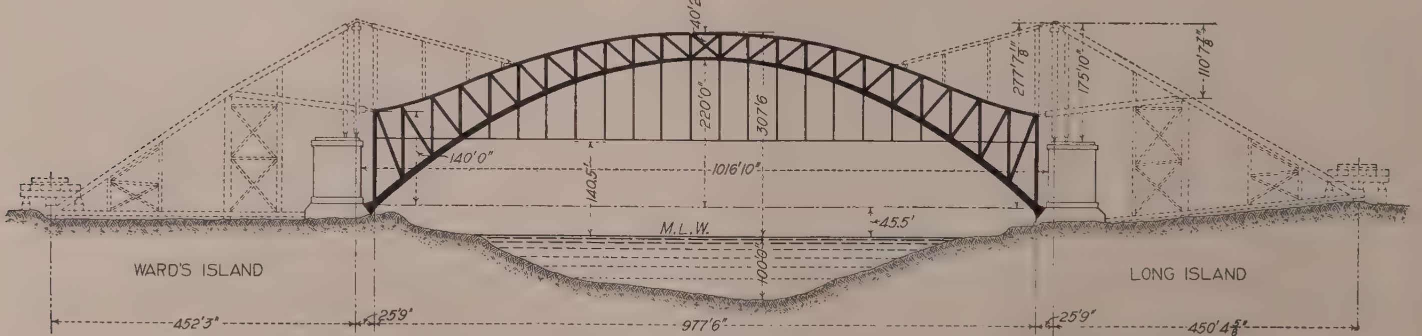
TRUSSES

The lower chords of the spandrel braced two-hinge arch trusses, 60 ft. apart on centers, are parabolic curves with a rise of 220 ft. and a span of 1017 ft. on centers of skewback bearings, corresponding very closely with the clear span of the bridge opening between faces of abutment piers. The top chords are reversed curves, increasing the depth of the truss from about 40 ft. at the crown to 140 ft. at the skewbacks.

The trusses are divided by vertical members into twenty-three 42½-ft. panels each braced by a single diagonal except in the center panel which is X-braced. The skewback centers are 45 ft. above mean low-water and the top of the top chord at the center of the span is about 308 ft. above mean low water. The top chords are extended beyond the end vertical posts into the towers. All of the truss members are built up of plates and angles and are in single-panel lengths with riveted connections. All splices are 100 per cent riveted excepting those of the bottom chords which are 70 to 80 per cent riveted. Tension splices occur only in the web members.

The principal truss member is the bottom chord which, on account of the heavy dead load, is subject to compression only. It has a double rectangular closed cross-section with a uniform width of 6½ ft. over all throughout and an overall radial depth varying from about 7½ ft. at the crown to 11½ ft. over all at the skewbacks. Its construction is unusual in that the deep vertical webs are each made in two sections with a longitudinal joint in the neutral axis spliced by wide cover plates on both sides. The vertical webs are connected by transverse radial diaphragms near panel points and intermediately and both top and bottom flanges are connected by full-length cover plates. The maximum bottom chord piece has a cross-sectional area of 1385 sq. in. designed for a stress of 28,650,000 lb., and the piece 51 ft. long weighs 182 tons. Cast steel shoes are bolted to the ends of the chords and take bearing on corresponding cast steel skewback pedestals.

The trough-shape top chord has a uniform depth of about 4½ ft. and width of 6½ ft. over all and is made of two built I-beams with their inner top flange angles connected by a continuous coverplate and



Hell Gate Four-Track, Spandrel-Braced Arch Span Superstructure. Temporary Erection Installation Dotted their inner bottom flange angles connected by lattice angles, and bottom plates. A cross-sectional area of 385 sq. in. is provided for the maximum stress of 7,730,000 lb. and the heaviest top chord member weighs 40 tons. The web members have a rectangular cross-section made of two built channels with their flanges turned in and latticed by inside angle bars. The radial bottom chord joints are planed to bearing on the middle third, on each side of which there is a slightly tapered clearance ⅛ in. wide at the top and bottom flanges. This construction approximates hinge joints during erection and defines the distribution of dead-load stresses through the chord web, allowing live-load stresses to be distributed through the full width riveted splices.

SECONDARY BRACING

The top and bottom chords are connected by X-brace laterals and a third similar system is provided in the plane of the floor platform. The three systems are connected by heavy vertical and inclined portals at the intersection of the bottom chords and floor platform. All vertical posts are connected by transverse sway-bracing. The lateral system forms a horizontal truss about 93 ft. deep with its chords supported from the main trusses at panel points. These chords are fulcrumed at the intersection of the floor platform with the lower chords of the arch trusses and beyond this point cantilever three panels toward the center of the river, where they have expansion joints with the center sections of the chords. Shore ends of the chords are anchored to vertical pier members. Very heavy portals above the floor and X-bracing below it, transmit wind stresses from the top chord and floor lateral systems to the abutment masonry.

Horizontal plate girders at the intersections of the floor platform and the arch truss lower chords resist longitudinal stresses from the momentum of train and the action of brakes and transfer the stringer thrust to the arch chords.

The roadway platform 93 ft. wide and 140 ft. in clear height above mean low water, carries four lines of railroad tracks between trusses and two sidewalks outside of them. It intersects the lower chords of the arch trusses at the third panel points from the skewbacks, and the center portion, 722½ ft. long between them, is suspended from the bottom chords by vertical members at panel points. The ends of the floor platform are supported directly by the vertical members of the arch trusses. The suspended floorbeams are box plate girders 93 ft. long, 42 in. wide, and about 10 ft. deep over all in the middle, the depth diminishing to 7½ ft. beyond the trusses. Between the trusses the top and bottom flanges are reinforced by full-width cover plates and the webs are connected by diaphragms in the lines of the eight deep cross stringers and the four sidewalk stringers. They are supported by pin-connections through the webs of the I-shape vertical suspenders which pass through the floor beams. Each floor beam weighs about 86 tons. Trough-shape reinforced concrete single track deck slabs are supported on the top flanges of the stringers and are covered with broken stone ballast in which the standard track is laid. The sidewalks and spaces outside the outer tracks are floored with plank.

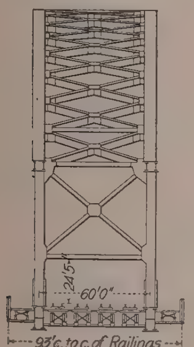
ERECTION

The water in the channel has a maximum depth of 100 ft., a tidal rise and fall of about 6 ft. and a high tidal velocity. The erection of the bridge on falsework would therefore have necessitated the obstruction of the channel and the construction of very massive and costly temporary supports 370 ft. high. It is planned to avoid these features by the erection of the semi-arch trusses simultaneously, from skewback to crown, by the cantilever method with the top chords anchored to counterweights. The span will be erected before the completion of the abutment piers and the top chord ties will pass over the lower portions of the pier towers to connections with the braced anchorage frameworks about 325 ft. high and 475 ft. long from the skewbacks to the center of the counterweights.

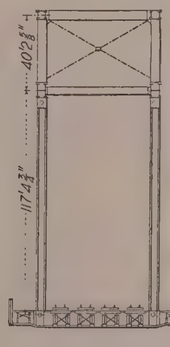
The ties at the ends of the top chords will be nearly horizontal at the river ends, and will be deflected over a knuckle joint to the inclined anchorage members. After the truss has been built out five panels ties will be connected to the top chords at the haunches, carried over tall vertical posts on the abutments and connected to the main inclined ties. The long tension members will be intermediately supported by vertical bents about 100 ft. apart. When the haunch ties are put in service the end ties will be cut off. The semi-trusses will be erected in positions slightly above required elevation, and adjustments in the outer connections will be slacked off to lower them to final bearing and complete the crown panel joints. The counterweight ties will be riveted steel members proportioned for maximum stresses of 3800 tons for each truss and the counterweights of about 5300 tons for each end of the bridge will be supported on platforms made of girders borrowed from other portions of the Hell Gate Bridge or adjacent viaduct spans.

On May 1, about 10,000 tons of structural steel for the main span had been fabricated and it is expected that the erection will be commenced in July. Both ends of the span will be erected simultaneously and each of them will be assembled by a steel traveler moving on the roadway platform and another on the top chords. It is estimated that the erection will be completed in 1915. The heaviest pieces to be handled in the field will weigh about 200 tons and there will be about 1,000,000 1¼-in. field-driven rivets, some of them over 11 in. long, all driven by pneumatic hammers.

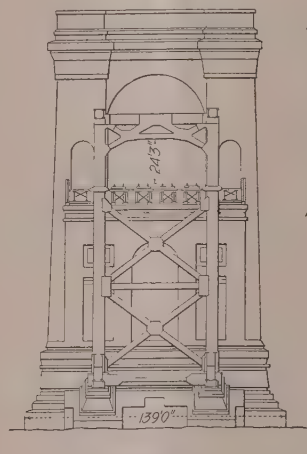
Samuel Rea is president of the New York Connecting Railroad, of which Gustav Lindenthal is consulting engineer and architect. He has designed the bridge and is



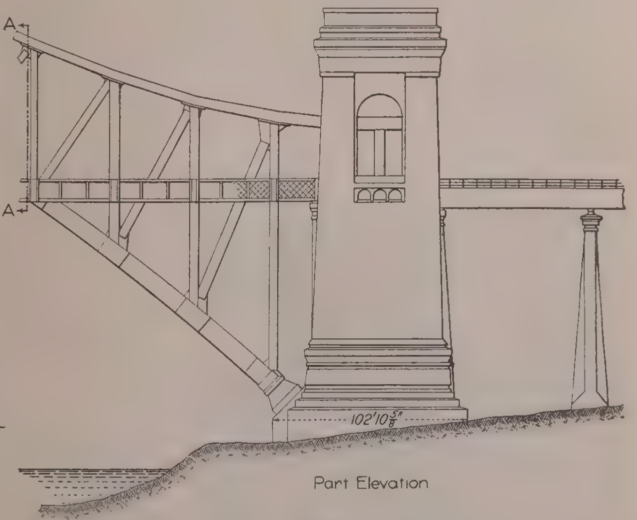
Section A-A



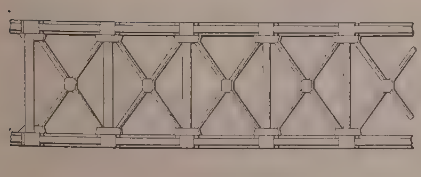
Section at Center



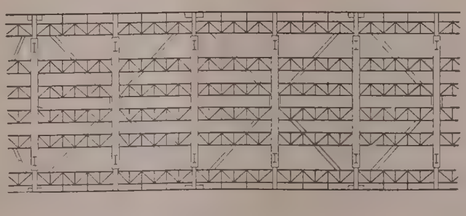
Section at End



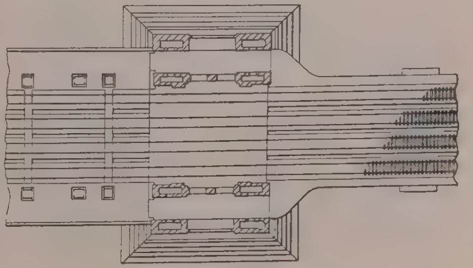
Part Elevation



Bracing between Top Chords



Steel Floor System



Tracks and Flooring

Skewback Bearings, Main Towers, Roadway Plan, Lateral and Sway Systems and Trusses of 977½-Foot Span acting as chief engineer of its construction. O. H. Ammann is assistant chief engineer and H. W. Hudson is construction engineer. The American Bridge Company is contractor for the fabrication and erection of the steel work, the P. Ryan Construction Corporation is the contractor for the tower bases, the Snare & Triest Company is the contractor for the towers, and the deep foundations for the Ward's Island tower were constructed by the Railway Company on force account under the direction of G. Lindenthal, P. G. Brown acting as managing engineer.

Lining the St. Louis Waterworks Tunnel with Concrete

Concrete Is Pneumatically Placed Behind Mounted Forms

A PHOTOGRAPH of the first lined section of the St. Louis waterworks tunnel is shown herewith. In the rear is a portable form, 36 ft. long, mounted on a steel platform from the sides of which angles rise to support the crown. The sides or "wings" are hinged or pinned to gusset plates near the tops of the angles. At the lower end they are held away from the platform by rods in which are turnbuckles. The angle-iron ribs have a series of blocks of wood bolted to them to form nailing pieces for the 1-in. lagging. Strips of No. 22 gage tin were placed over the 1-in. boards.

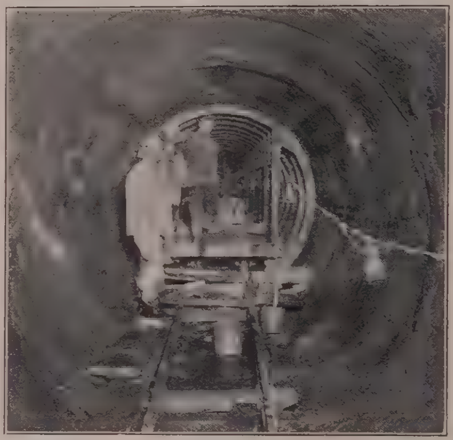
The operations in the removal of the form to a new section after concrete has been deposited are, first, easing off of the turnbuckles, thus pulling in the "wings"; then lowering the crown enough to clear by jacks under the platform. Tracks will already have been laid over concrete placed one day in advance in the invert section, so that it only remains to move the forms ahead and reverse the operations with the jacks and turnbuckles to bring the forms to line and grade.

As the minimum section of concrete is 9 in., varying up to 18 in., as noted in the description of the driving operations in the Engineering Record of May 9, page 525, a wooden bulkhead 9 in. wide is placed over the end of the forms and the remaining space is banked up by filled cement bags.

Concrete is delivered pneumatically by a pipe to the center of the form at the crown. It falls away from the far end on a slope of about 30 deg. When the form is half filled the pipe is removed to the bulkhead.

Pneumatic Concrete Mixer

Aggregate for the concrete is apportioned at the top of the shaft, the material being wheeled by three men from a stock pile to a measuring hopper with a slide gate delivering into an 8-in. pipe suspended in the 89-ft. shaft. At first water was admitted into the charging hopper, but to prevent sticking a separate line was run to the mixer from a tank located on the surface. To obviate the danger of the falling charge injuring the mixer, a wooden chute lined with sheet iron and leading into the mixer was placed at the bottom. The charges were $1\frac{1}{2}$-bag batches and were controlled by one man at the top to operate the slide in the charging hopper and the water valve after receiving an air signal from the man at the mixer.



Section of Lined Tunnel at St. Louis

Air was available from the tunnel driving plant to the extent of 950 ft. from an Ingersoll-Rand compressor and 675 ft. from a Norwalk unit.

Concrete in the first section was deposited in three and one-half hours, and it was intended to complete the shore tunnel, 537 ft., in May, using one form and concreting on alternate days. For the 2252 ft. of river tunnel it is not yet decided whether to lay a concrete line the whole length of the tunnel or move the mixer to the center point.

The cost of the pipe will have to be balanced against the cost of transporting the aggregate from the shaft to the mixer, using the 3-ton General Electric storage battery locomotive employed to handle the muck cars in driving the tunnel. It is planned to use two sets of forms and deposit concrete behind each on alternate days.

The pneumatic mixer and equipment were furnished to the Fruin-Colnon Contracting Company by the Concrete Mixing & Placing Company, of Chicago.

The work is being carried out for the water department of St. Louis under E. E. Wall, water commissioner. Gurdon G. Black is chief engineer of the supply and purifying division and E. C. Davis is resident engineer.

A HYDROGRAPHIC SURVEY of the Colorado River has been provided for by an appropriation of $50,000 by the Department of the Interior, according to a statement by H. Z. Osborne, of the Arizona and California River Regulation Commission.

Reinforced Concrete Piles to Be Ninety-One Feet Long

SEVENTY feet has been the maximum length of concrete piles heretofore used in dock work at San Francisco, but in preparing plans for pier 35 in that port the Board of State Harbor Commissioners decided that in order to maintain the same type of construction for the entire length of the pier it would be worth while to construct 91-ft. piles. Accordingly, advertisements for bids were recently published which require concrete piles of this length in nearly one-third the total area of the pier.

Pier 35 is to be 200 ft. wide with a length of 817 ft. on one side and 975 ft. on the other. Concrete piles will be used exclusively, except in the fender line, and will be spaced 12 ft. one way and 10 ft. the other, supporting a reinforced concrete deck. Additional piles will be driven, of course, beneath the railroad tracks and the columns of the shed, which is 161 ft. wide and extends the full length of the pier. The depth of water varies from 41 ft. at the shore end to 56 ft. at the outermost point. Careful soundings have led to the adoption of eight standard-size piles ranging in length up to 91 ft., which meet the varying requirements on the entire area covered.

CROSS-SECTIONS

Up to 58 ft. in length the piles will be 16 in. square, between 58 and 77 ft. the section will be 18 in. square, and over 77 ft. a 20 in. square section is specified. These sections are reinforced to safely withstand the strain of being picked up by a sling attached to the pile at two points, these points being 20 per cent of the total length from each end and the negative bending moment at the points of support being taken the same as the positive bending moment at the center of the unsupported length. However, it has been found that even with the 70-ft. piles it is desirable, for convenience in placing, to use slings that attach at three points, and the longer piles will probably be handled in this way also.

The 91-ft. piles will weigh 15 tons each and are expected to be able to carry, in addition to their own weight, a load of 40 tons. The longest piles in the pier will be imbedded for a length of about 35 ft., but only 25 ft. of this is firm enough to be considered effective in supporting the load. The concrete mix used in the piles will be the same 1 to 5 proportion specified in all San Francisco harbor work, that is, to one part of cement there will be crushed rock, pea gravel and sand totaling 5 parts and mixed in the proportions that give the maximum density. Each consignment of materials is tested and the requisite proportions are determined at arrival on the job. Two sizes of crushed rock and two kinds of sand are at times employed to secure the desired density. The piles are required to be allowed to set for 45 days before being driven.

A CHEAP CONCRETE WAREHOUSE, 1000 ft. long, on the property of the Southern Pacific Terminal Company at Galveston, Tex., divided into four compartments, complies with underwriters' requirements and was built at a cost of slightly less than $1 per square foot. The floating foundations are supported on a sandfill dredged from Galveston Bay.

Driving Long Battered Piles with Steam Hammer and Derrick Boom

San Francisco and Machina Piers, Havana

Two and Four-Story Reinforced-Concrete Structures with 85-Foot Concrete Pile Foundations in Deep Water and Soft Mud

THERE have recently been completed for the Port of Havana Dock Company, Cuba, two large deep-water piers built of reinforced-concrete. Important features of this construction are, piles of unusual length, girder-design reinforced-concrete pile caps, columns with riveted reinforcement independently sufficient, provision for resisting impact and heavy transverse stresses, and a number of novel superstructure details.

The Port of Havana Dock Company operates under a concession originally granted to Sylvester Scoville in 1905, which permits the construction of four piers providing wharfage for eight vessels with lighters and coal barges between them. The estimated available annual import is 804,000 tons of which 80 per cent remains in Havana for distribution. Business tends to frequent small-order shipments of very general character and mixed cargoes; formerly merchandise was almost exclusively lightered from vessels in Havana Harbor at a cost of about $3 per ton. The new piers provide direct handling of freight between shore and ship at a greatly reduced cost, provide safe and sanitary storing for merchandise and food stuff, and are rapidly becoming a general market for sales and deliveries of the latter. With the opening of the Panama Canal it is expected that the volume of imports here will be greatly increased and that the piers will be taxed to their full capacity.

GENERAL DESCRIPTION

The piers are located on the west side of the harbor opposite Casa Blanca and the plant will eventually consist of four piers with connecting office and warehouse building. The portion already built consists of two two-story piers 164 ft. wide and 262½ ft. apart in the clear. The pier lengths are 660 and 680 ft. and they are built in water from 20 to 40 ft. deep with a tide of 18-in. and a bottom consisting of 15 or 20 ft. of soft mud overlaying sand or clay. In order to accommodate the marginal space the first floor is at an elevation of 5 ft. 3 in. above mean low water. The second floor is 29 ft., and the peak of the roof is 57 ft. above mean low water, thus giving a maximum height of about 150 ft. from the foot of the piles to the peak of the roof.

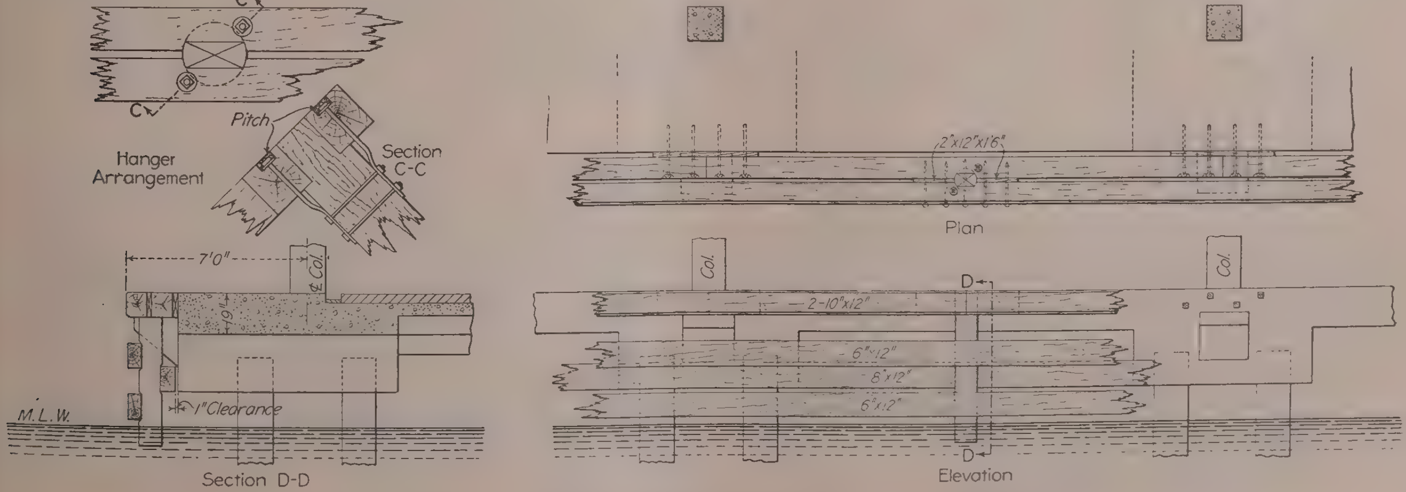
All freight received is classified under five headings of which one consisting of soap and all food stuff, and another consisting of light hardware and machinery are stored on the first floor because they are more quick moving and have the greater tonnage. The other three classes, namely, crates, bales, and merchandise of large volume and light weight; drugs, chemicals and express matter; and drygoods are delivered to the second story by escalators and elevators for light and heavy passages respectively.

For the handling of freight there are provided Boston trucks for sacks and light boxes, heavier wheel trucks with a capacity of 1000 lb., three man trucks with a capacity of 4000 lb., and four-wheel Reynolds' trucks for small uniform packages. Owing to the great variety of freight the installation of portable machinery has been delayed to await developments indicating what will prove of the greatest economy.

The head house, for office and warehouse purposes, is 800 ft. long parallel with the shore and 65 ft. wide and is from three to four stories high with provision for ultimate extension to five stories. It is of ornamental brick and concrete construction with pile foundations in water 20 to 25 ft. deep. A refrigerating and cold storage plant with a capacity of 30,000 cu. ft. is operated on the third floor.

CONCRETE PILES

In designing the foundations wooden pile structures surrounded by concrete built in caissons to protect them from the ravages of the teredo were first considered but were abandoned on account of the great depth to hard bottom. Reinforced-concrete piles were finally adopted. Their length varies from 45 to 85 ft., by 5-ft. increments, and they all have a rectangular cross-section 16, 18 or 20 in. square, reinforced as indicated in the illustration of the maximum pile. The pile reinforcement was proportioned to the bending moment of the pile supported horizontally from two points located so as to make positive and negative moments about equal. These points were fixed by the insertion of permanent transverse gas-pipes providing convenient attachments for handling. The longitudinal reinforcement consists of round bars from ¾ in. to 1⅛ in. in diameter and constitutes from ¾ to 1½ per cent of the pile area. Splices were made with laps of 40 diameters. The piles are hooped with ¼-in. square rods and have special basket reinforcement at the top to take the hammer impact. The piles were designed specifically to avoid the use of any patented or patentable features. There are in all about 4000 piles which were made by



Framing of Spring Fenders, Bearings and Anchorage to Concrete Deck

Windows and Continuous Doors in Side of Pier Shed

the contractors in a plant located about a mile from the site as described in the Engineering Record of April 27, 1912, page 470.

The piles are arranged in clusters of four to eighteen piles each, and are capped with reinforced-concrete about 3½ ft. thick and from 6 to 12 in. clear above low water. The lateral dimensions vary from about 7 to 24 ft. In proportioning their reinforcements the caps were considered as intersecting grillages, plate action being disregarded. The maximum dead load of 15 tons per pile was allowed plus a live load of 25 tons. The resulting load of 40 tons per pile was determined by the observed capacity of numerous test piles driven between the shore line and pier head.

The pile caps are designed for loads applied as indicated in the accompanying diagram for a ten-pile cluster, the methods for other clusters being similar. P is the total reaction per pile, including the load from the first floor which, although really reducing the moment is disregarded for additional safety. A and B are distances from the column to pile centers; D is the diameter of column less 3 in. = 39 in.; F is the first floor load. The moment at X is $M_x = P\ (3A - 2B)$. The tensile stress in the reinforcement is $T = M\ (\frac{7}{8} D) = M/36.6$. The total area of reinforcement steel is A_s — $T/16,000$. The number of 1-in. diameter rods required is $N = A_s/0.785 = 1.27\ A_s$. Compressive stresses in the concrete were disregarded and about one-half of the rods were bent up. The computation for the moment YY is similar to that for the moment M_x.

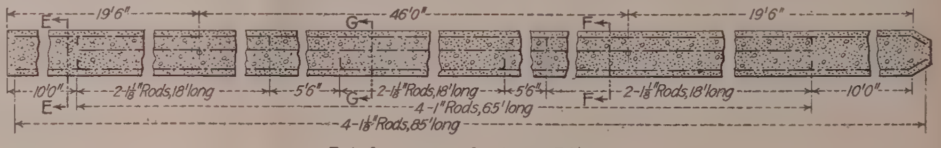
PIER DECKS AND FENDERS

The pier deck or first floor of the superstructure was designed for a live load of 250 lb. per square foot and is a continuous reinforced-concrete slab with an average thickness of 12 in., supported between pier caps on reinforced concrete beams 15 to 18 in. thick and of 7-ft. span. It is covered with wooden block pavement and carries columns spaced 20 to 30 ft. apart to reduce obstruction for trucks and drays. The decks are considered as horizontal cantilevers tending to break or bend in a horizontal plane and held rigidly at the shore end. For this reason no expansion joints were provided in it. The vertical piles were chiefly relied upon for transverse strength, battered piles being considered too expensive in proportion to the slight additional stiffness provided by their use.

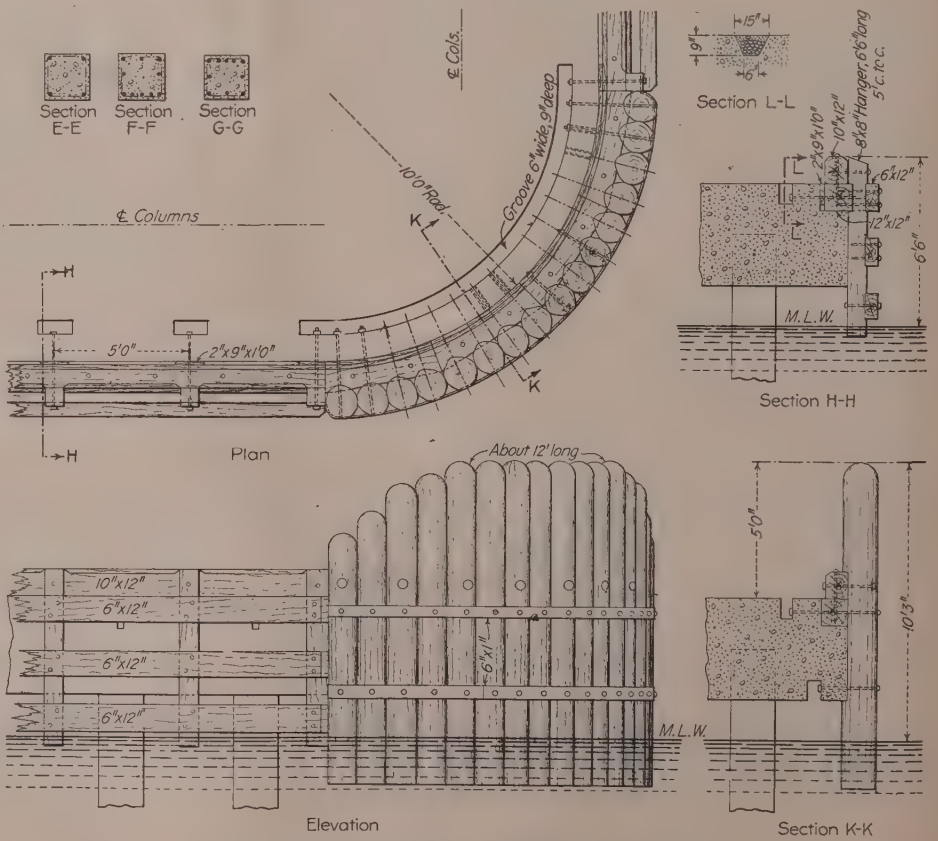
On account of the great length required and the ravages of the teredo, fender piles were not used and resistance to impact of vessels was provided by special horizontal fender timbers with bearings against the floor platform at panel points. These were made in double layers with the outside layer bearing intermediately between the panel points so that a double spring action was secured and direct impact at bearings avoided, as shown in the accompanying details. At the rounded pier corners there were provided special curved fenders with vertical outside timbers. Here the horizontal timbers were secured to the concrete platform by bolts with their nuts located in a groove in the floor slab which, after the construction was completed, was sealed by a pitch and gravel filling covered with cement.

SUPERSTRUCTURE

The columns have a riveted reinforcement with a rectangular cross-section made of four angles latticed and having sufficient strength to be erected in advance and support the concrete forms and wet concrete. After the floors were built the columns were enclosed with wooden forms and filled solid with concrete protecting the exterior surfaces and having cross-sections from 15 to 30 in. square. The floorbeams are of ordinary reinforced concrete construction and the roof beams are reinforced by light lattice girders which like some trusses one-story deep in the third story of the head house, are entirely enclosed in concrete. The second story is proportioned for a live load of 400 lb. per square foot and has safely sustained double that weight. As there is no snow in this climate and no opportunity for live load on the roof it was made very flat, thus receiving practically no wind pressure, and is of a very light design rein-



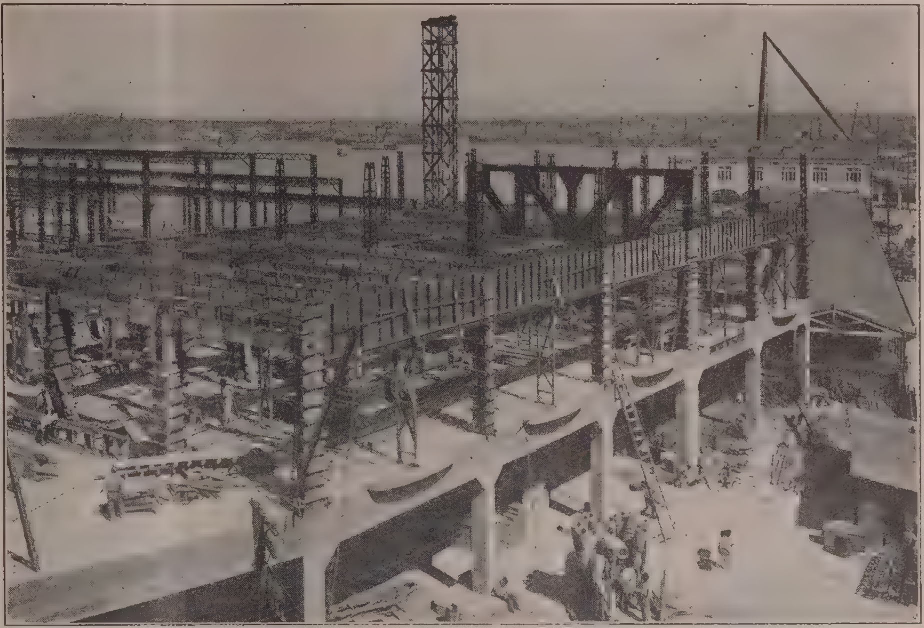
Reinforcement for Long Pile



Vertical Fenders on Rounded Corner of Pier Deck forced with only about 4 lb. of steel per square foot.

The interior pier walls and the exterior walls of the head house are chiefly of brick and cement mortar, plastered inside and outside with cement mortar. The gutters are moulded in the concrete roof and the wide moulded cornices are supported on structural iron brackets riveted to lattice girders. These lattice girders together with others in the building being entirely embedded in concrete are of special construction intended to utilize the potential strength of the concrete protection to supplement the steel, and while their upper flanges are made of the usual T-section with pairs of angles adopted to resist the erection stresses the lower flanges are made of flat bars proportioned for the necessary tensile strength and relying on the enclosing concrete for lateral stiffness.

The pier shed walls are of concrete 6 in. thick. They are reinforced by metal fabric and are seated in chamfered grooves molded in the upper surface of the floor concrete. The wall slabs are carried continuously in front of the columns to which they are bonded and are integral with the belt courses and cornices. The roof gutters pitch to down spouts 3 in. in diameter which were made with tin tubes embedded in the axes of the columns and continued in a straight line through the pile caps to their outlet just above water line, thus making it very easy to free them from obstruction. It is considered that the saving of concrete thus effected balanced the cost of the tin and that when the latter disappears from rust the smooth regular hole in the concrete will serve equally well.



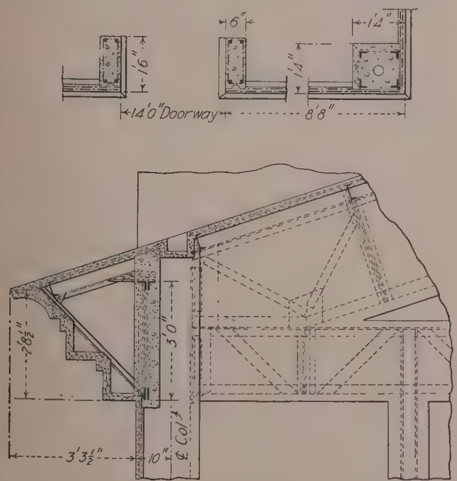
Erecting Sheet Skeletons and Concreting Columns on Pier Deck

ERECTION

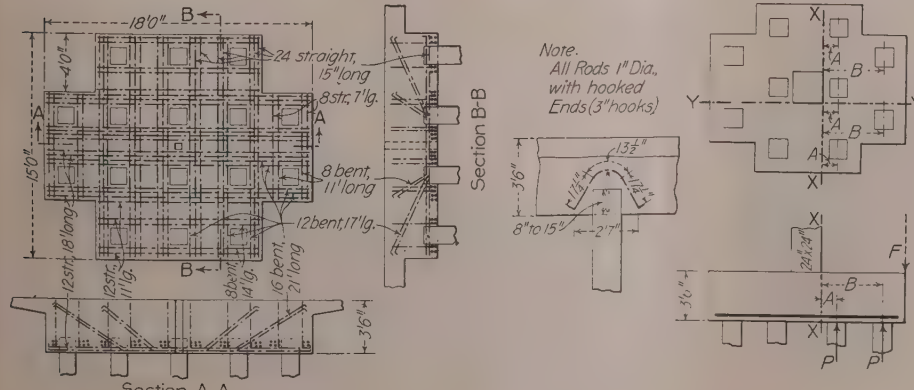
One pier was completed before the second was commenced in order that facilities could be afforded on it for the passenger landing before the latter was disturbed on Pier No. 2. Both piers were, however, put in service as rapidly as decks were completed and enclosed while awaiting the entire completion of the work, which required forty months.

The pile driving was done with a floating equipment, the piles being handled both in horizontal and vertical position by pairs of slings fastened to the gas-pipe holes and attached to a bridle suspended from a derrick boom. Care was taken to keep the pile with the marked side up and they were driven by a 6-ton No. 1 Vulcan steam hammer seated on the top of the pile and attached to it by slotted vertical links allowing the whole maximum pile weight of 17 tons to be efficient for settling it from 10 to 20 ft. into the mud while the hammer was still supported by the derricks and afterward allowing the hammer to be entirely supported on the piles. A rope mat was used to cushion the hammer and the piles were driven by an average of 500 blows to a penetration in the hard stratum of ½ in. or less for the last ten blows. The estimated length of most of the piles was correct, but a few of them were found too long and were cut off by pneumatic chipping hammers.

The construction involved about 30,000 cu. yd. of concrete which was mixed in a floating plant equipped with a hoisting tower from which the concrete was chuted to position in the structure. The pile caps were cast in separate forms and their edges were rebated to receive the floor slabs which with the deck beams and girders were cast in forms suspended from the pile caps.



Wall, Doorway, Roof and Gutter Construction



Regular Reinforced-Concrete Grillage Pile Cap

The work was designed and its execution directed by Barclay Parsons & Klapp, New York, and was executed by MacArthur, Perks & Company, also of New York.

Penalties and Liquidated Damages

Contradictory Provisions in Contracts and Qualified Release of Claims

By WILLIAM B. KING

Of the Bar of the Court of Claims, Washington, D.C

THE recent decision of the Court of Claims in the case of the Noel Construction Company, arising out of the construction of the officers' mess building at the Naval Academy, presents two points of general interest in the law of engineering and architectural contracts—the first relating to contradictory provisions in regard to damages for delay and the second relating to the effect of a qualified release.

The contractor was delayed in the completion of the building from a variety of causes. The United States suffered no actual damages by reason of this delay except for inspection charges and other smaller items amounting to $663.77. Upon making final payment the government was not satisfied to deduct this sum, but deducted $5,466 on the ground that the government had been damaged during the delay by the loss of interest upon the sum invested by the United States in the building.

The petition presented to the Court of Claims raised the question whether the department had a right to deduct the sum stated for this reason or whether it was confined to the damages actually incurred. The specifications contained two provisions in regard to damages for delay. One of these agreed that deduction should be made at the rate of $100 a day as liquidated damages for every day of delay in completion; the other agreed that the amount of every expense to the United States caused by delay might be deducted and withheld from the payments due the contractors and that the contract price so reduced should be accepted in full compensation.

Claimants' counsel argued that the provision for liquidated damages at $100 a day must be read in the light of the second provision; that the actual expenses to the United States caused by delay should be deducted. The two provisions, it was argued, were inconsistent with each other and, under these circumstances, nothing but actual damages should be deducted.

The court agreed with this contention and said that these two provisions of the contract were so utterly and entirely irreconcilable that neither one of them could be enforced and that the contract must be construed as if it had no provision in it in regard to damages for delay. The common law, in the absence of such agreement, would give the United States actual damages. These were found to be $663.77. Consequently, the court said that that was all which should be deducted. The theory of deducting for supposed interest charges was declared to be unsound.

The contract required the contractors, before final payment, to execute a final release of all claims and demands against the United States. They notified the Secretary of the Navy that they did not wish to release their claim for the $5,466 deducted. The Secretary of the Navy said that the release would have to be signed in the form required by the contract, but said that it might be accompanied by a statement submitting the contractors' attitude in relation to the balance withheld. The contractors thereupon accompanied the release by a statement that, in signing the release, they did not mean to release the claim for the balance withheld as damages. The government raised the question whether the release, accompanied by the letter, operated to prevent the claimants from collecting this amount by suit.

The court said that, when the Secretary of the Navy gave the claimant permission to accompany the absolute release by a qualification, the two papers must be read together. It said that the Secretary of the Navy never intended that an unfair advantage should be taken of the result of such permission and that the government should not, either in good conscience or law, be allowed now to insist that the release was unqualified. Consequently the letter was held to qualify the release and save the claim as presented.

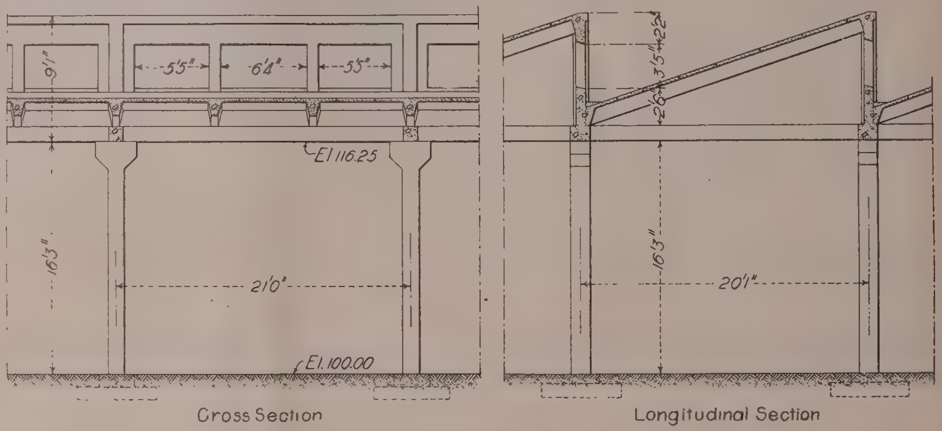
This precedent is of importance in cases where the contract contains conflicting provisions or a requirement of a release before the final payment.

ALL-STEEL PASSENGER CARS to the number of 7377, exclusive of Pullman cars, were in service in the United States Jan. 1, 1914.

Ten Acres of Concrete Buildings Constructed by the Unit Method

Separately Molded Columns, Girders and Roof Slabs Were Used in the New $300,000 Cotton-Handling Plant at Galveston, Texas

TEN acres of one-story concrete buildings, costing $300,000, have been erected by the unit method of construction for the Galveston Cotton Compress & Warehouse Company. All columns, girders and roof-slabs were cast in forms on the ground, the separately molded pieces were then raised into their proper places in the buildings and the joints were grouted with rich concrete. Concrete construction was selected primarily to reduce insurance rates on stored cotton. Since the new buildings have been in use the insurance rate has dropped from $1.78 to 45 cents per annum, and it is claimed that a saving of $750,000 has been effected by the use of fireproof construction.



Cross Section Longitudinal Section

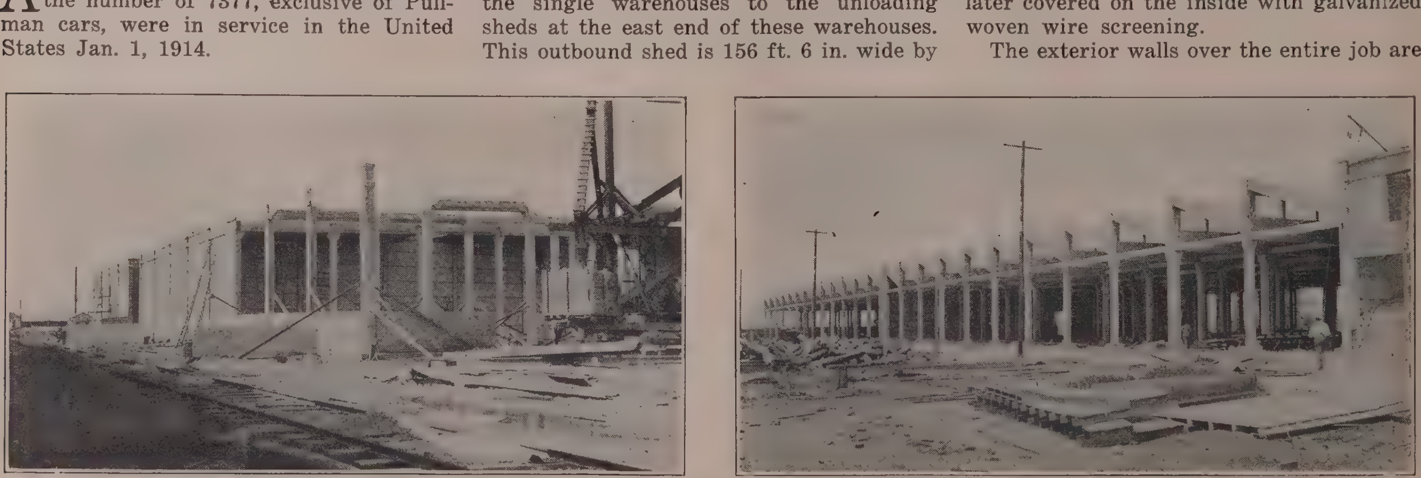
Sawtooth Construction at Galveston Cotton Handling Plant

The compress building, containing most of the machinery and about which the activities of the plant center, is 217 ft. long by 138 ft. wide. The classing sheds, which extend north and south from the compress, have sawtooth-roof construction throughout, to afford good lighting. The north shed is 486 ft. long by 138 ft. wide, and the south one 369 ft. by 138 ft. Sawtooth-roof construction is claimed to be particularly economical with the unit system of building. There are four so-called single warehouses, 185 ft. long by 80 ft. wide, and three double warehouses, 185 ft. long by 160 ft. wide. The outbound shed begins at the compress and extends east between two of the single warehouses to the unloading sheds at the east end of these warehouses. This outbound shed is 156 ft. 6 in. wide by 237 ft. long. The unloading shed extends the full length of the plant and adjoins the warehouses. The railroad switch tracks run along this shed, and all the cotton comes in here. It is 1070 ft. long by 50 ft. wide, and the roof cantilevers over the box cars as they stand on the track.

All these various buildings total approximately 376,900 sq. ft. of floor area, or about 8.7 acres. The total area covered by the plant, including fire lanes, is 425 x 1070 ft. or 10.5 acres, and provision is made for extensions to the west and south, which will eventually double the capacity of the plant. The cotton is handled by a very elaborate telpher system, which forms an unbroken chain from the unloading shed to the warehouses, from the warehouses to the classing sheds, from the classing sheds to the compress, and from the compress through the outbound shed to the tracks.

One of the construction features was the sawtooth roof over the classing sheds. The vertical frames which form the fronts of the sawtooth were cast in one piece and acted as the girder to support the roof slabs which form the slope of the sawtooth. One end of a roof slab rests at the bottom of one frame while the other end rests on the top of the frame one bay ahead. A tie beam from column to column makes the construction rigid. Instead of having windows in the vertical frames, openings were left and later covered on the inside with galvanized woven wire screening.

The exterior walls over the entire job are



Methods of Unit Construction for Sawtooth Roof, Columns and Side Walls of Galveston Cotton Plant

8 in. thick. The interior walls are all fire walls 12 in. thick.

The lighting of the buildings is accomplished in a great measure by skylights. These skylights are also made in units. Reinforced concrete ribs are used, and the wire glass rests on these in much the same manner as on a steel rib. The ribs are held at their exterior end by a concrete curb.

EXPANSION JOINTS

Two expansion joints were placed in the classing sheds and in the unloading shed because these buildings run continuous for 1070 ft. These joints are parallel to the girders and were made by putting in two separate girders at the column rows where the joints occur. Steel plates were set on the column heads and on the bottoms of the girders at their ends between these plates is a nest of steel rollers. These rollers are in a carriage so that they always remain parallel and roll easily, for between girders there is a 2-in. clear space.

How the Separately Molded Slabs of Concrete Are Raised and Placed in Their Proper Positions in the Buildings

With the unit method of construction it was possible to inspect each structural member before it entered the building, and all defective members were rejected. Since the members were all cast on the ground where the concrete could be well puddled, and all voids filled, the buildings present a very pleasing appearance. Wherever drilling was necessary the concrete was found to be so dense and hard as to make the drilling extremely difficult.

The original plans were made by John R. Fordyce, Jr., consulting engineer, of Little Rock, Ark., who also laid out the cotton-handling system, but the plant was later laid out to accommodate the unit method of construction. Although the work was begun in a small way in February, 1913, delays due to abnormal rains and trouble with the footings made the equivalent time of starting May 1. The work was completed Dec. 1, or just seven months later. The contract was executed by the Unit Construction Company, of St. Louis, of which C. D. Morley is general superintendent.

A NEW BRIDGE across the Danube River, connecting the railroad systems of Roumania and Servia, is expected as a result of a treaty recently concluded between these countries. The structure will be located at Iziganus in Roumania and Brza-Palanka in Servia. It will be a single-track bridge 16 ft. wide, and provision will be made for a future second track. The free height of high water will be 46 ft. The Roumanian Government will design and build the bridge, which is scheduled to be in service within the next four years.

Tractor-Trailers for New York Street Cleaning

Commissioner John T. Fetherston Recommends Establishment of Model District Equipped with Complete Modern Appliances

BY establishing a model street cleaning district in the borough of Manhattan, replacing horse-drawn equipment with tractors and trailers and introducing improvements in methods of garbage collection and disposal Commissioner John T. Fetherston of the Department of Street Cleaning, New York City, estimates that with an initial expenditure of $253,000 an annual saving of $54,342 can be effected in maintenance expenses. Among the advantages which will accrue from the adoption of Commissioner Fetherston's plan are these: Department property valued at $690,000 will be returned to the city for sale or other use. Nuisances and menaces to health resulting from the open ash-can, the open collection cart, and the open waterfront dump will be eliminated. Each street in the district will be cleansed daily by machine washing, scrubbing or sweeping. During snow storms streets will be maintained open for traffic by machine snow sweepers.

NECESSITY FOR IMPROVEMENTS

The three main functions of the Department of Street Cleaning are the cleaning of the streets, the collection of refuse, and the disposal of solid wastes. The system now in use is practically the same as that installed by Commissioner Waring over seventeen years ago. Streets are cleaned mainly by dry hand-sweeping supplemented by hose flushing and aided by the only semi-modern machinery in the department —seven horse-drawn power flushers and twelve horse-drawn squeegees. The street washing or flushing equipment is wholly inadequate to control the dust which is a menace to the health of the community.

Refuse is collected in open carts. Covers for garbage receptacles are required by law, but as a rule they are loose, ill-fitting and not fastened to the can. Dumps along the waterfront, inland or at railway stations, are open, causing nuisances from odors, dust and flying paper. The methods now in use by the department are characterized by Commissioner Fetherston as antiquated, dangerous to the health of the community and costly in operation.

PROPOSED NEW METHODS

The main feature of the new plan replaces horses with power-driven motor tractors, each fitted with three types of trailers, one for street flushing or sweeping, one for refuse collection, and the third for plowing, sweeping and hauling snow. The remainder of the equipment will consist of standard types of receptacles for holding garbage or ashes and a transfer station or dump provided with power-operated devices for handling refuse. The collection equipment, including household receptacles, as well as the transfer station or dump, will be designed as a closed system to obviate present nuisances from odors, flies, dust and loose paper.

For the initial installation, a representative district containing all kinds of structures and grades of inhabitants is desirable. It is proposed to install the new system in district 6, which is on the East Side and extends from 12th Street to 40th Street, and from the East River to Fifth and Sixth Avenues.

The separation of household refuse into three classes will be continued under the new system. Garbage will be placed in a can of standard design, having an attached cover and painted a distinctive color to distinguish it from the ash can, which likewise will be of similar design with attached cover. Rubbish will be tied in bundles as required by existing ordinances. It will be necessary to furnish each building with the first set of cans, at least in district 6.

TRACTOR-TRAILER OUTFITS

Twelve tractors of nominal 5-ton type with thirty-six trailers will be required to replace horse-drawn equipment in district 6. These will be equivalent to thirty-six single function power trucks and constitute the main feature of the new method. No other city has taken up the tractor-trailer system, but it is used by private companies for hauling. Its adoption for municipal cleaning, according to Commissioner Fetherston, solves the problem of decreasing the fixed charges by extending the functions of the trailers and hours of work of the tractors.

Each tractor will be provided with three types of trailers. For collecting refuse, a trailer body fitted with removable compartments to hold at least ten cubic yards of refuse will be provided and so designed that material from the standard cans will be transferred to an appropriate compartment without creating dust or nuisance. All classes of refuse will be collected at one time and not more than one collection trip per day will be made through any street. This will result in all cans being removed from sidewalks and areas except at the removal period, which can be closely timed for every street.

For cleaning streets a trailer containing a water tank holding about 1500 gal. with sprinkling, flushing and revolving broom attachments will be furnished, and for snow work a plow and revolving broom following street railway practice is contemplated. Manufacturers of auto trucks have been consulted as to cost and feasibility of the combination tractor-trailer system and have declared the apparatus to be both practical and economical.

Book Reviews

The city-manager plan of municipal government is the subject of a 35-page paper-bound booklet containing several short articles and a digest of short ballot charters for cities. The topic is discussed under the three following headings: "City-Manager Plan to Date," "Principles Underlying City-Manager Plan" and "Representative Council Plan." (New York, The American City. 25 cents.)

From the U. S. Geological Survey comes, as Bulletin 552, a publication entitled "Results of Triangulation and Primary Traverse in Ohio," compiled under the direction of R. B. Marshall, chief geographer. It covers work done from 1900 to 1911 inclusive in co-operation with the State. Two appendixes contain records of primary triangulations made by the U. S. Lake Survey and the U. S. Coast and Geodetic Survey. All of these data are incorporated into a map dated Jan. 1, 1912, showing the horizontal control for the State. (Washington, U. S. Geological Survey.)

A list of publications pertaining to Government ownership of railways has been issued as Bulletin 62 by the Bureau of Railway Economics under the direction of Frank Haigh Dixon, statistician; Richard H. Johnston, librarian, and Logan G. McPherson, director. The pamphlet contains seventy-four pages, the references being classified according to countries and States. In a prefatory note the authors state that "every effort has been made to include references to all available literature on the subject—good, bad and indifferent—for and against Government ownership," and the bibliography should be invaluable to those interested in the subject. (Washington, D. C., Bureau of Railway Economics.)

The Illinois State Water Survey has issued its annual report for the year ended Dec. 31, 1912, containing a summary of the work done by the laboratory and engineering divisions under the supervision of Edward Bartow, director. In addition to the general, engineering laboratory and scientific reports there are papers on volumetric determination of potassium in mineral waters, effect of Chicago sewage on the Illinois River, incrustation in water mains at Mount Vernon, Ill., and occurrence of manganese in the Mount Vernon supply. There are also a report of the sanitary survey of the Des Plaines River and a chapter on rural water supplies. The report is published by the University of Illinois, Urbana.

The University of Wisconsin has issued the following bulletins in the Engineering Series, Vol. 7: No. 3, 52 pages, "Investigations of Hydraulic Curve Resistance Experiments with 3-Inch Pipe"; No. 4, 15 pages, "Test of a Jet Pump"; No. 5, 58 pages, "A Test of an 8-Foot Flash Wheel," and No. 6, 57 pages, "Investigation of Flow Through Large Submerged Tubes, Part 3, Experiments with Submerged Draft Tubes." The first three are by Leland Rella Balch, C.E., research assistant in hydraulic engineering at the university. The last is jointly by George Jacob Davis, Jr., C.E., dean of the college of engineering, University of Alabama, and formerly assistant professor of hydraulic engineering at the University of Wisconsin, and Mr. Balch.

"Tests of Bond Between Concrete and Steel," by Duff A. Abrams, is issued as Bulletin 71 of the Engineering Experiment Station of the University of Illinois. This bulletin furnishes one of the most exhaustive studies of the amount and distribution of the bond stress between concrete and steel which have appeared. The results of tests of about 1500 pull-out specimens and 110 large reinforced-concrete beams are given. The tests covered a wide range of ages, mixes, size of bar, length of embedment, condition of storage, method of applying the load, etc. Both plain and deformed steel bars were used.

Bond resistance may be divided into two principal elements, adhesive resistance and sliding resistance. In all of the tests measurements were made to determine the relation of slip of bar through the concrete to the bond resistance at different stages of the tests. A considerable bond resistance is developed before a measurable slip is produced. It was found that after slipping begins there is a well-defined relation between the amount of slip of bar and the bond resistance for small slips. For plain bars slip begins at about 60 per cent of the maximum bond resistance; with further slip the bond resistance increases rapidly until a slip of about 0.01 in. is reached, which represents the maximum bond resistance. The amount of slip corresponding to a given percentage of the maximum bond resistance is remarkably constant for a wide range of ages, mixes, conditions of storage, etc. Slip of bar begins at a bond stress equal to about one-sixth the compressive strength of cubes made from the same concrete. The maximum bond resistance is equal to about one-fourth the cube compressive strength.

For deformed bars the relation of slip of bar to the bond resistance was not materially different from that of plain bars during the early stages of the test; during the later stages of the test the bond resistance varied widely with the type of bar and was found to depend on the area and slope of the bearing surfaces presented by the projections of the bar.

Twisted square bars were found to be inferior to plain round bars on the basis of bond resistance per unit of area of the surface of the bar.

The usual method of computing the bond stress in a reinforced-concrete beam does not take account of all the phenomena of bond action. Slip was first observed in the middle region of the span at loads producing a tensile stress in the reinforcement of about 6000 lb. per square inch. As the load was increased slip of bar progressed through the outer thirds toward the end of the beam. In the beams reinforced with plain bars end slip began at about 67 per cent of the maximum load; for the beams with certain types of deformed bars the value was 51 per cent. In the tests of reinforced-concrete beams it was found that a very small amount of end slip represented critical conditions of bond stress.

COAST SAND DUNES, SAND SPITS AND SAND WASTES. By Gerald O. Case, Consulting Engineer for Coast Works. Board, 5 x 7 in.; 162 pages; 43 illustrations. London, England, St. Bride's Press, Ltd. 5 shillings net.

When the author states in his preface that no book on this important subject has hitherto been published in Great Britain he evidently refers to special types of sandy embankments described. The preface states that the object of the treatise is to present the advantages of the proper utilization of inblown sand, so as to form it into a protection against coast erosion, instead of leaving it, as at present, an active agent in coast erosion and in the laying waste of fertile land. The author has drawn upon the experience of the British Isles, Africa, India, America, France, Holland and Belgium in compiling his data.

THE PSYCHOLOGY OF MANAGEMENT. The function of the mind in determining, teaching and installing methods of least waste. By L. M. Gilbreth, M. L. Cloth, 5½ x 8 in.; 344 pages. New York, Sturgis & Walton. $2 net.

A verbose, rambling book that, however, emphasizes strongly some of the important points in cutting down costs in industrial enterprises. It is too tiresome, however, to hold the attention of the busy man. Most of the ideas have been better presented before; in fact, the book is no more than a rehash of what others have written on scientific management and efficiency engineering, with, however, an altered viewpoint. It endeavors to estimate the value of the various methods suggested by Dr. Frederick W. Taylor on psychological grounds. In this the author might have been successful if his scope had been less ambitious and if he had given more of his time—and so saved more of the reader's—to condensing his material.

NEUZEITLICHE WASSERVERSORGUNG IN GEGENDEN STARKER BEVOLKERUNGSANHAUFUNG IN DEUTSCHLAND. By Dr.-Ing. A. Heilmann, Regierungsbaumeister. Paper, 7 x 9½ in.; 160 pages; 21 illustrations and 2 inserts. Berlin and Munich, R. Oldenbourg. $1.30.

(Reviewed by George A. Johnson, New York.)

In his book on "Present Water Supply in Places of Great Congestion in Germany" Dr. Heilmann has considered the problem mainly from a politico-economical standpoint. With the exception of a small portion of this publication, wherein the hygienic side of the question is dwelled upon, with a brief description of the different methods of water filtration of the present day, the author has gone deeply into such questions as "Municipal Ownership," "Private Ownership," "The Cost of Production of a Supply," and its functions, "Price of Water," "Water Taxes," "Consumption of Ground Water and Political Economy."

The threatening danger to agriculture arising from the excessive use of ground water and the harm to fish and other industries caused by the heavy consumption of water from streams have been carefully looked into by Dr. Heilmann, and the advantages of impounded water supplies over others are considered at great length.

A number of diagrams and tables giving the increase in population in Germany, the consumption of water in German cities, the development of municipal and private water works, and comparative costs of production and selling prices of water in different German localities, all help to visualize the subject treated in this book, which, *per se*, is of an intermediate character.

As is seen from the title of the book, in studying this important question of meeting the demand of an ample and sanitary water supply for the ever-increasing population of large cities, Dr. Heilmann has limited himself to Germany only, but as such the question is treated in a rather thorough manner.

ENGINEERS' HANDBOOK of tables, charts and data on the application of centrifugal fans and fan-system apparatus, including engines and motors, air washers, hot blast heaters and systems of air distribution. Edited by Willis H. Carrier, Chief Engineer, The Buffalo Forge Company. Leather, 4½ x 6¾ in.; 581 pages. Illustrated. Buffalo, N. Y., The Buffalo Forge Company. $3 net.

The necessity of a handbook for ventilating engineers has long been felt, especially one giving exhaustive information on fans. Engineers and architects will, therefore, appreciate the information presented in this book. The greater part of the data is the result of tests and researches made by the engineering staff of the Buffalo Forge Company in the testing laboratories of the company, and many of these investigations have been made mainly to obtain data for this handbook. The results of these investigations have in most cases never been heretofore published except in the proceedings of engineering societies.

Mainly the book is divided into five parts: "Properties of Air," "Applications," "Air Ducts," "Apparatus," and Appendix. Part II is subdivided into heating, ventilation, air washing, cooling, humidifying and drying, mechanical draft, exhaust systems and miscellaneous applications. Part IV covers fans, fan testing, fan capacities, fan dimensions, heaters, air-conditioning apparatus, steam engines and their practical application and the selection of apparatus for heating and ventilating. There are numerous diagrams, tables and drawings. The necessary text is condensed to a minimum. The only indication that the book is written by a manufacturing company is that at intervals in the text are shown photographs of machinery, the captions of which refer to the company's stock.

THE JOB, THE MAN, THE BOSS. By Dr. Katherine M. H. Blackford and Arthur Newcomb. Cloth, 5½ x 8 in.; 266 pages. New York, Doubleday, Page & Company. $1.50 net.

The Blackford employment plan has become known, by name at least, to most industrial employers in this country. Unfortunately, however, those who have charge of men in the civil-engineering field—on construction or in offices—seem to care less than industrial leaders about the welfare and efficiency of their workers. To many of these, therefore, the story told by this book will be new.

The volume is inspiring. Its first sixty pages are crammed with hard-headed common sense regarding the development of employees. The principles are fundamental—as applicable, therefore, to the management of a drafting-room force as to a gang of laborers.

The book is devoted mainly to the Blackford employment plan, which, in its essence, consists in hiring, disciplining, transferring and discharging labor for all departments through a central employment office, and, secondly, in selecting employees to fill positions defined by exact specifications. The second essential, naturally, demands that a careful analysis be made of the applicant, and here is introduced the Blackford method of analysis—a method that produces most astounding results in the hands of those competently trained and with aptitude for the work. This feature of the plan—analyzing men largely by facial characteristics and other physical features—has been the subject of much controversy. That the scheme has been successful on a wide scale, however, demonstrates its value. It is sure to fail, however, in the hands of the incompetent. The method of analysis is explained very fully and should prove of much value to those even who handle but a few men.

The thesis of the volume can best be shown by two quotations: "This (the proper development of personnel) means the selection for each job in our organization of the one man out of all others who, by natural aptitude, training and experience, is best fitted to fill all the requirements of that job, and suited to its environment and conditions. . . . The ideal, so far as wages and salaries are concerned, is not to fix a rate of pay for any particular job and then to find some man or woman (efficiency not specified) willing to accept that rate of pay, but rather to fix upon the standard requirements in aptitude, training, experience and consequent efficiency for that job, find some one who meets the requirements, and then pay him enough to secure his best constructive thought."

The volume can be read with profit by every manager of men.

Letters to the Editor

What People Will Not Drink

SIR: When the reclamation of the Imperial Valley in California, by diverting the copious flood of the Colorado River, was proposed, little was said about the quality of the drinking water. Now, with an area of 350,000 acres under the irrigation system, all water used for domestic purposes in the valley, both on the ranches and in the towns, has to be taken from the thick chocolate fluid which runs through the big irrigating ditches.

One Year's Deposit of Mud

At Brawley, in order to prepare the ditch water for drinking, the town has built several large settling basins where the mud in the water is at first allowed to precipitate, the clear water afterward being pumped into an elevated storage tank, from which it gravitates through the city mains. Some idea may be gained of the great amount of mud deposited by the accompanying view of the bottom of one of these basins after the water had been drained off. The man is standing on the original floor of the basin. A deposit of 30 in. of soft silt mud collected in twelve months.

Glendale, Cal. V. W. KILLICK.

Demolition of Tower Building, New York

SIR: Referring to article "Demolition of Tower Building, New York," in your issue of June 6, page 648, since the daily press has from to time furnished its readers highly colored accounts of this building, some facts regarding the structure may be interesting, at least historically, as bearing upon the introduction and development of skeleton structures.

The late Bradford L. Gilbert conceived the plan, and its execution was intrusted to the then existing Architectural Iron Works. It is a fact that this was the first attempt, in New York City, to build a so-called skeleton frame building. It turned out, however, to be of hybrid construction, with cast-iron columns in the gable walls, bolted together through the flanges, and without cross-bracing of any kind in the narrow or Broadway wing of the structure. The columns were raised to a certain level, at which level they were topped with a rolled beam girder, which in turn carried the solid brick gable walls to the roof.

As the building was about topped-out, doubts as to its stability arose. A prominent consulting engineer called to report on existing conditions did not hesitate to say that it was criminal to lay another brick in the building. At this point the writer was requested to provide a remedy. With the building almost under the roof, the task was hardly alluring. However, stability was secured in the narrow Broadway wing by introducing vertical angle-iron trusses in the plane of the trusses and transverse to the building. The southerly chord of these trusses was formed by the cast-iron columns in the southerly wall. The northerly chord, consisting of two angles back to back, was placed in the longitudinal partition dividing the offices from the hallway. This was necessary because the hallway could not be obstructed. The diagonals were attached to the angle-iron chord by panel plates, and to the cast-iron columns by means of bent plates and tap bolts. The cast columns in the northerly gable wall were therefore still isolated, except so far as they were held by the wall-beam girders and the floorbeam framing, all bolted to the cast-iron lugs of the columns.

It can readily be seen that from the viewpoint of construction the scheme was not admirable, but as a makeshift, under extraordinary circumstances, it fully answered its purpose.

It may be added that this pioneer effort is more fully recorded in the "Transactions" of the American Society of Civil Engineers, Volume 27, September, 1892.

GEORGE A. JUST,
Consulting Engineer.
Long Island City, N. Y.

Small Contracts for Large Works

SIR: In reference to your editorial of May 9 on the subject of "Small Contracts for Large Works" and subsequent comments on same the following remarks may be of some interest.

1. Large contractors can rarely compete on small contracts. They are usually from

20 to 40 per cent higher than responsible small contractors.

2. The overhead charges of large contractors are usually between 20 and 40 per cent of the contract price.

3. "Small Contracts for Large Works" are usually completed in far less time than large contracts for an equal amount of work.

4. In general better work is done on small than on large contracts.

5. Even when errors of judgment are made by the engineer in charge of small contracts, they can nearly always be rectified at less than the 20 to 40 per cent additional that the work would cost if let in one large contract.

6. Large contractors have failed before now and will probably fail in the future, and a large general contractor losing money is about as hard a proposition as an engineer can handle.

These, at least, are my own experiences on private, municipal and Government works. I would like to learn the experiences of other engineers in similar cases.

A. STELLHORN,
Civil Engineer.
Fort Leavenworth, Kans.

Proposed Building-Height Restriction in Minneapolis

SIR: The undersigned has read with interest in your issue of May 30, page 610, the article entitled "Proposed Building-Height Restriction in Minneapolis," in which is reprinted a portion of the proposed Minneapolis ordinance.

The undersigned happens to be one of the parties who has been active in opposing certain provisions of this ordinance. As drafted it is a fair sample of the legislative work with which highly theoretical and thoroughly unpractical persons seem to be attempting to saddle the public of this country. The purpose of the ordinance, it is claimed, is the protection of citizens against lack of sufficient light and air, and the prevention of congestion. With the above-avowed purpose in view, the framers of the ordinance calmly proceed to base the height of buildings upon the width of the street or roadway upon which they face, without regard to the character of the property abutting such roadways. They arbitrarily limit the height of buildings fronting 60-ft. streets to 105 ft. without regard to the fact that quite a number of such buildings would face public parks and other permanently open public spaces, ranging up to 15 or 20 acres in area. A building which fronts on an 80-ft. street, with a depth of 150 ft. on a 60 ft. street, they propose to chop off at a point 66 ft. from the front, thus making it impractical for many buildings which corner on an 80 and a 60-ft. street to be built higher than the limit allowed for the 60-ft. street. They base their deductions entirely upon the angle of light coming from above, without regard to the direction in which buildings face or the streets run. They entirely ignore the possibilities of artificial ventilation and artificial light. They disregard the area of light courts or the arrangement of buildings and the use to be made of them.

We are even told that this is only the beginning of such legislation, and at an early date we may expect to be confronted with the proposition to build the back line of buildings up in step fashion, the rear walls retreating a certain distance from the lot line for each foot in height. We are told this is the way it is done in London, or some other place, and that that is sufficient reason for doing it here, where conditions can never be parallel.

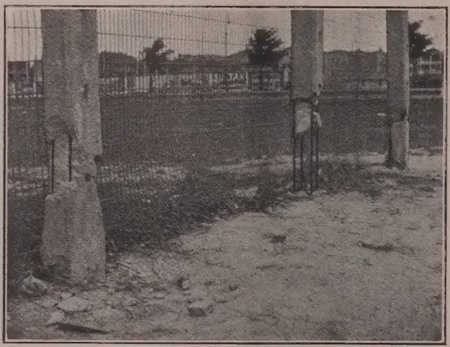
The writer does not wish to be understood as opposed to progressive, constructive and sane legislation, but he believes the country would benefit by a rest from "college-professor" engineers, legislators and "busy bodies."

Minneapolis. WALTER H. WHEELER.

[Needless to say the Engineering Record is not in sympathy with Mr. Wheeler's point of view. There may be details in the Minneapolis ordinance that need amending, but the principle is so good that the measure should prevail. Slight defects can be ironed out later.—EDITOR.]

Frost Action on Concrete Posts

SIR: The accompanying photographs should be of interest to readers of Engineering Record, illustrating as they do what may happen to a perfectly good (?) concrete post when it is subjected to frost action. The posts are planted in a public playground and support a wire netting backstop. They stand 12 ft. or more above the ground, are about 10 in. square at the bottom, and taper to about 5 in. square at the top. I am told that they were set out in the spring of 1913. I saw them frequently last fall, but do not remember any signs of disintegration in them.



Fence Posts Damaged by Frost

During the past winter this playground was flooded for skating, and the ice was probably a foot thick at times. When the ice melted this spring nearly half of the posts on the field were in the condition shown in the accompanying photograph. The breaks are in general at or a little below the water level.

We all like to draw our own conclusions as to why things happen, especially in regard to concrete. These posts seem to have been made of a medium rich mixture, with aggregate of coarse sand and gravel; on the broken sections the proportions seem to vary. Apparently the concrete was mixed very dry and tamped into the forms. The surface is porous. The reinforcing consists generally of 4½-in. square twisted bars, one in each corner of the post. I saw no indication of ties, bands or hoops of any kind in the broken posts, and am of the opinion that none were used. There seems to be a standing disagreement among your readers as to the value of vertical reinforcing, with or without hooping, in a column; it may be that the lack of this hooping here is an important clue.

It should be mentioned, too, that nearly all of the posts, whether broken at the base or not, show decided rust streaks parallel to and opposite the reinforcing rods. A few of these streaks run the entire length of the post. On one of the posts the piece split off from the side broke along this rust line.

These are the facts of the case—the main ones, at any rate—and to me the lesson is obvious.

GEORGE C. STONE,
Boston. Civil Engineer.

Back Flow of Waste Water

SIR: With the improvements due to closer supervision of drainage areas, to better and more general filtration and to the several methods of sterilization there comes a greater degree of confidence in the quality of water and a larger use of it. This feeling of confidence is increased by the wide advertising given to the quality of supplies through the publication by many cities of their low typhoid-death rates. With all of these changes the greater density of population in tenement houses, apartments and hotels adds to the difficulties in the distribution of a safe and satisfactory supply.

During the current year at a gathering of members of an association interested in water supply and sanitary affairs, held in a city justly proud of recent improvements in these features, one of the leading hotels assigned to its guests "rooms with bath." The tubs, of excellent quality and present or once fashionable design, were so constructed that the hot and cold water entered behind an ornamental metal shield, placed only 2 or 3 in. above the waste outlet. The lower part of the circular shield was cut away to give the water a downward direction. When a tub was in use and being filled from either the hot or the cold-water system a failure of pressure in that system of pipes permitted the dirty water to leave the bath tub by the same route it had entered, and once beyond the faucet in the entering pipe the restoration of pressure would cause that water to be delivered to other fixtures in other rooms, and on other floors. It was in effect like turning wash water into the distribution system of a village or small city. And this occurred repeatedly during the brief session.

Many people, knowing that a water supply has been filtered, turn to a hot-water fixture and a lump of artificial ice for greater safety. It is not pleasant to think of the extent to which they may be mistaken. In a large building and elsewhere every one knows how frequently air rushes into the pipes for a brief interval when a hot or cold water faucet is opened. Having in mind this common experience no one would think of designing a wash bowl to admit hot and cold water at the bottom, but the bath-tub design referred to is quite as bad, and worse in some respects.

Every owner, plumber, inspector, the National Board of Health and every State board should unite to condemn all low-delivery types of bath tubs wherever found; and as check valves would be worthless, they should insist upon the removal or the reconstruction of every tub so that the water would enter above the proper water line and the overflow outlet.

New York City. H. F. DUNHAM.

APPROXIMATELY one-fourth of all timber cut in Colorado in 1911, states a bulletin of the Forest Service, was used by the mining industries in that State.

Bronx Terminal, New York City

Bulkhead Work on a Project for a Waterfront Development in a Borough of the Metropolis at Present Practically Unserved

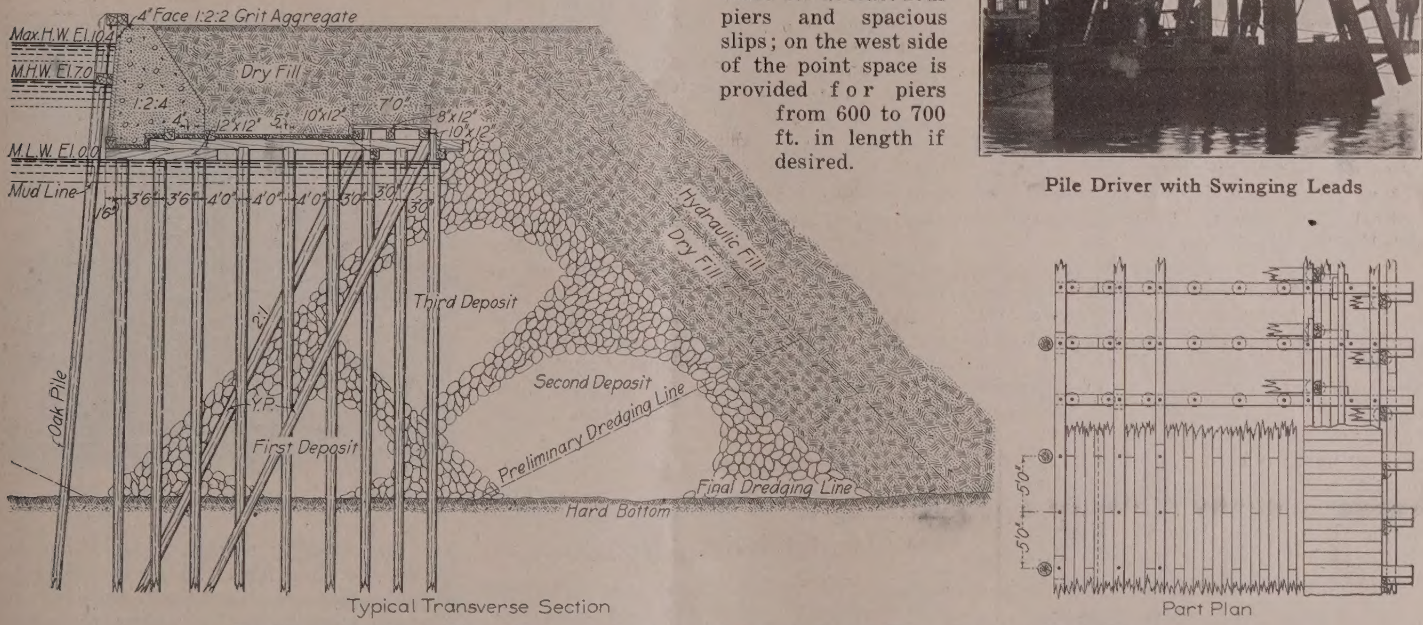
By J. R. MARSH
Chief Engineer, Bronx Terminal Corporation

A WATERFRONT development of considerable magnitude, involving unusual construction features, is now under way on the East River at Hunts Point, New York City. The Bronx Terminal Corporation is the owner of the property involved, which extends from the waterfront northwest, about to the line of Eastern Boulevard. The company proposes to develop a manufacturing terminus for steamships and railroads, which will not only considerably reduce the freight congestion in New York Harbor but will greatly increase the industrial prestige of the Borough of The Bronx.

Hunts Point lies above the east end of Rikers Island, opposite Flushing Bay and just west of the mouth of the Bronx River. The main thoroughfare leading to the point, Hunts Point Avenue, is a continuation of East 163d Street and runs through the heart of the recently developed Hunts Point section. The channel beyond the point forms the practical, if not exactly the geographical, junction of the East River and the Long Island Sound, thus providing a safe and, as careful investigation has proved, a shorter route to New York harbor than the channel through the Narrows. This is true not only for transoceanic traffic but for traffic from southern ports and the Panama Canal.

The channel at and above Hunts Point has an average depth of at least 30 ft. below mean low water. This depth of water will be carried up to the face of the bulkheads now under construction. The Government pierhead line just east of the point permits the construction of piers 1000 ft. long, and as a length of bulkhead of 1760 ft. is under construction ample space is provided for at least four piers and spacious slips; on the west side of the point space is provided for piers from 600 to 700 ft. in length if desired.

Pile Driver with Swinging Leads



Typical Transverse Section

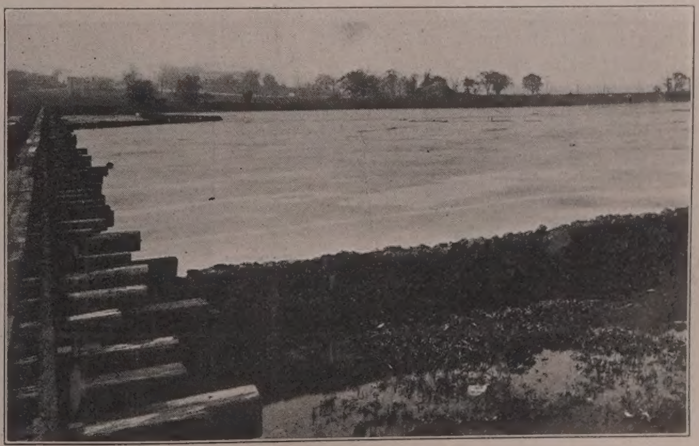
Part Plan

Details of Special Bulkhead Being Built at Bronx Terminal, and Three Stages of Rock Deposit

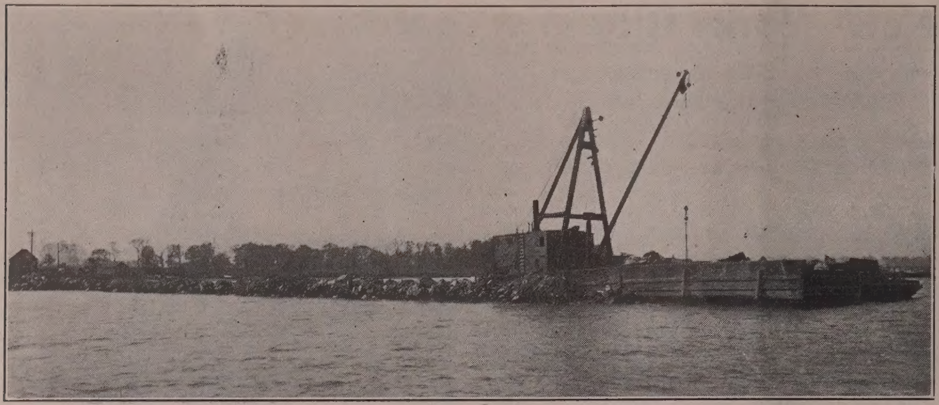
The proposed terminal railway in the Bronx, connecting as it will with the New York, New Haven & Hartford, the New York Connecting and the New York Central & Hudson River Railroads, will provide direct connections for freight to all parts of the country, while the completion of the Southern Boulevard subway, with its express station at Hunts Point Avenue, will amply fulfil other transportation needs.

An unusual condition has been encountered in the construction of the bulkheads, owing to the presence of a mud shoal extending out almost to the main steamship channel and easterly around Clason Point. The edge of this shoal is quite clearly defined; the top surface is practically flat and only from 1 to 4 ft. below mean low water. Soundings made along the bulkhead lines to determine the depth of hard bottom showed the mud to be of a heavy consistency, with a quantity of boulders in suspension. This mud has a depth to the east of the point of from 20 to 45 ft. below

Excavating Dike Material from Surface of Ground



Section of Dike Made from This Surface Material



Building a Part of the Rock-Fill Bulkhead with a Derrick Scow

low water; to the west it was found to extend to varied depths up to 65 ft. Below the mud an extremely compact sand-and-gravel bottom is encountered with a quantity of boulders and at one point bedrock. The construction of a stable bulkhead under these conditions became a matter of considerable difficulty. It was finally determined to adopt a type consisting of a heavy rock-fill resting on the hard bottom and faced with a pile structure with a decking at low water and a concrete quay wall with earth backing above. A typical section of this bulkhead is shown.

A contract for the construction of this type of bulkhead, together with the necessary dikes along the return lines of the property, was awarded last October to the Foundation Company, of New York City. Special floating equipment was constructed to meet the requirements of the work, consisting of a derrick barge, pile driver, compressor barge and concrete boat. The pile driver, with its swinging leads, and the concrete barge, with its overhead mixer prepared to pour concrete directly into forms at any stage of the tide, have features of unusual interest.

Construction of Bulkheads

In the construction of the bulkheads it was necessary to dredge preliminary trenches to a depth of from 30 to 35 ft. below low water, or less if hard bottom was encountered, in order to insure the rapid placing of the stonefill forming the backbone of the bulkhead, particularly since stone dumped between the piles forming the bulkhead facing must be small enough in size to avoid the lateral displacement of the piles. The dredging contract was awarded to the Atlantic, Gulf & Pacific Company, of New York, who have been using a 20-in. hydraulic dredge, pumping the material removed back upon the swamp lands, which comprise a large part of the total area. To confine the filling within the property limits levees were built, using the thick matted top of the swamp, which was cut into blocks and neatly piled. To date more than 400,000 cu. yd. have been dredged.

In depositing the bulkhead stone it was decided to bring the material both by rail and by water—the first deposit of rock directly among the bulkhead piling to be dumped from cars running on a temporary trestle supported on pile caps, the second rock deposit from scows towed in back of the piling, the necessary water depth being provided by the preliminary dredging, and the final deposit again from cars dumped toward the rear, rather than toward the front of the bulkhead. After the rock is in place a quantity of fine stone and sand will be deposited to assist in sealing the voids.

In order to bring the cars to the bulkheads trestles were constructed from high lands out along the side lines of the property, thus also allowing the dumping of earth and rock for the retaining dikes out to the bulkheads. It was found, however, on the west side of the point that the depth of sound bottom for a distance of several hundred feet shoreward from the bulkhead made the trestle construction impractical, and this section of the dike is now being constructed by dumping large derrick stone from deck scows. These stone gradually settle through the mud and bring up on hard bottom.

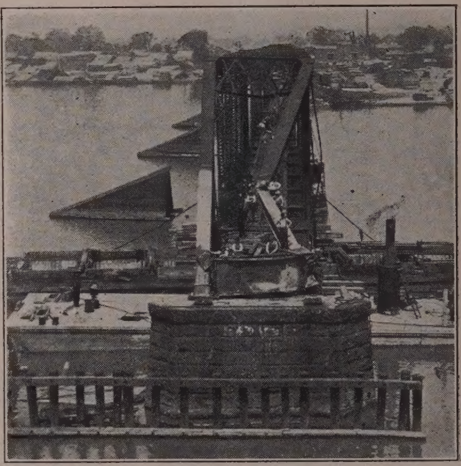
The work has been well organized, and the end of the calendar year should witness the completion of the bulkhead and dikes east of the point proper, as well as a small portion of the bulkhead just west of the point.

Raising a Wrecked Railroad Bridge with Dredges

Sunken End of a 177-Foot Span Lifted and Reseated by Dredge Boats and Scows

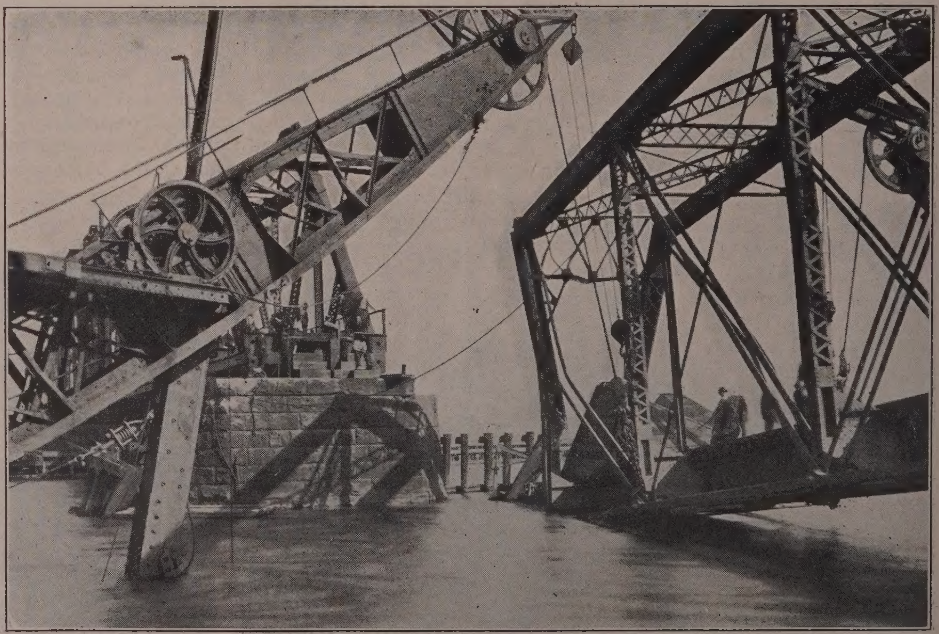
On June 14 a 360-ft. steel barge under tow, at a reported speed of 6 or 8 miles per hour, was caught by a brisk wind while passing through the draw of the Wheeling & Lake Erie Railroad bridge over the Maumee River at Toledo, and collided with the rest pier, cracking its masonry. It also crippled one of the inclined end posts and otherwise injured the adjacent 177-ft. fixed single-track through span and pushed the end clear of the pier so that it fell into the water and sunk to a depth of 12 ft., where it was arrested by old piling. The other end of the span remained seated on its pier.

To raise the fallen span W. L. Rohbock, chief engineer of the railroad, writes that hoisting tackles attached to the extremities of the booms of two dipper dredges with a nominal hoisting capacity of about 95 tons each were made fast to the third-from-the-end lower-chord panel points of the span, one on each side, and the hoisting engines on the dredge boats were operated to lift the end of the 210-ton span clear of the water. A water-ballasted scow was placed under the span as near the end as possible and blocked up to take bearing against it.



Damaged Span Restored to Position

The water being siphoned out, the scow raised the span high enough to permit a second scow to be placed under the end, and the span, steadied by the dredges, was gradually lifted high enough to be pulled back on the masonry and supported there. Falsework will be placed under the end of the bridge and the damaged steelwork will be repaired.



Two Dredges at Work Raising Fallen Bridge Span at Toledo